SITE STRUCTURE AND ORGANIZATION IN CENTRAL ALASKA: ARCHAEOLOGICAL INVESTIGATIONS AT GERSTLE RIVER

A

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SITE STRUCTURE AND ORGANIZATION IN CENTRAL ALASKA:

ARCHAEOLOGICAL INVESTIGATIONS AT GERSTLE RIVER

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Abstract

This dissertation presents a multi-dimensional analysis of site structure and organization at a multi-component deeply buried stratified site in the Tanana Basin in Central Alaska, Gerstle River. The primary objective of this research is to investigate patterning among the lithics, fauna, features, stratigraphy, and radiometric dating, within and among components and intra-component hierarchical spatial aggregates. These analyses are situated within and are explored in terms of technological and spatial organization.

Given the longevity of microblade technology (12000 BP to ~1000 BP) in Central Alaska and its presence in very different climatic and biotic regimes, understanding how microblades were used within a technological system and possible variations in microblade use could be useful in understanding technological change during the Pleistocene-Holocene transition and later Holocene times. This research analyzes microblades and other lithic classes at a number of levels (e.g., attribute, artifact, raw material, modification type, cluster, area, component, and site).

Results show a number of organizational properties used by Early Holocene populations at Gerstle River, providing a dataset useful for testing future models derived from experimental, ethnoarchaeological, and other middle range approaches. Patterns of technology and technological organization are more highly resolved when incorporating spatial analyses. Microblade technology is shown to be structurally complex, used for a variety of purposes and reflecting different stages of production and different modes of use and disposal, including microblade production, replacement, and discard.

Inferences about faunal procurement, subsistence, transport decisions, settlement patterns, and economy are made through a multidimensional faunal analysis. Non-human factors were not major agents in the formation of the assemblages. A spatial model of faunal processing indicates how space was used in processing multiple individuals of wapiti and bison.

Contextual data from lithic technology, faunal remains, features, radiocarbon dating, and spatial relationships are used to model several dimensions of organization present at Gerstle River, including site activities, technological organization, disposal modes, organization of space, redundancy, storage, seasonality, location, group size and economic structure, economy, and settlement system.

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CHAPTER 1. INTRODUCTION

Introduction: The Importance of Context

Alaskan archaeology stands at a crossroads both metaphorically and literally. Alaska's geographic location and archaeological potential places it in a significant position to address a wide variety of current topics in archaeology. Alaskan data can be used to develop frameworks for investigating the culture history of the Arctic and Subarctic regions. It can be used to explore patterns of site structure, settlement strategies, and subsistence of prehistoric and ethnographic hunter-gatherers in high latitude environments (e.g., Binford 1977, 1978a, 1980, 1991; Amsden 1977; Enloe 1993b). A critical aspect of Alaskan archaeology is the potential to examine the relationships among subsistence, technology, and landscape use during a period of climatic oscillation which also marked the initial colonization of the New World (~14000 to 8000 cal BP[1]). During this period, a number of cultural historical frameworks have been proposed for the Alaskan Interior (Cook and McKennan 1970; Cook 1975; Bacon 1977; West 1981, 1996; Dixon 1985; Powers and Hoffecker 1989; Holmes 2001). One view, that of a unilineal sequence of Paleolithic cultural groups (Nenana – Denali – Northern Archaic – Athabaskan) is untenable and appears to underestimate variability in the archaeological record (Bevers 2001b; Potter 2000, 2004b). Another view has emerged regarding the Alaskan Late Pleistocene/Early Holocene archaeological record, that different cultures lived side by side for hundreds if not thousands of years with very different technological traditions (i.e., generally differentiated by the presence or absence of microblade technology) (see Dixon 1999, 2001). This perspective too, may underestimate archaeological variability. Microblade technology in particular has been shown to have been integrated within a larger technological tradition that included formal and informal bifaces and unifaces along with various expedient forms (Powers et al. 1983; Clark and Gotthardt 1999). Given this integration, it follows that archaeologists need to understand how various artifact classes were organized within and among sites. This situates the problem of

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[1] Calibrated radiocarbon dates are listed as "cal BP" and uncalibrated radiocarbon dates are listed as "BP" following Kra and Stuiver (1986).

interpretation, whether functional or organizational, squarely in the realm of spatial patterning and site structure.

It is necessary here to briefly describe the process of interpretation generally used for explicating Interior Alaskan archaeology. Binford's (1983b:376-377) description of New World archaeological systematics is revealing, and relevant to the Alaskan literature. Assemblages are not described, but rather types are constructed on the basis of certain shared attributes. Binford (1983b:377) notes that

> cultures are then conceived as recurrent 'bundles' of types. Patterns of repetitive association at different sites of a number of different 'types' illustrate a 'cohesion' of traits said to represent a 'cultural' unit.

Binford argues that this process serves to mask real patterning in assemblage variability. One way to move beyond the limitations of this approach is to examine assemblage variability with respect to dimensions of organization, at the level of technological organization and use of space (landscape and intrasite).

To this end, this dissertation presents a multi-dimensional analysis of site structure and organization at a multi-component site in the Tanana Basin of in Interior Alaska, Gerstle River (49XMH-246). The approach taken in this study follows from Taylor's (1948) original call for archaeological investigations to examine multiple data types and reconstruct site use through the integration of contextual information. Rather than interpretation through ethnoarchaeological or ethnographical analogs, the approach taken here focuses on identifying patterns among data classes through the analysis of a number of dimensions that can condition the organization of space and technology through site structure.

The primary relevant data for Interior Alaskan prehistory consists of archaeological sites. To date, over 3,300 lithic sites have been documented in Interior Alaska (Potter 2000). Most information on early Interior Alaskan prehistory comes from a few excavated sites in central Alaska, whereas the vast majority of sites have received relatively little attention. Only six sites with Late Pleistocene or Early Holocene components have been excavated (over 20 m^2 of excavation) in the Tanana basin: Campus, Healy Lake Village, Chugwater, Gerstle River, Broken Mammoth, and Swan Point (Mobley 1991; Cook 1969; Maitland 1986; Lively 1988; Sheppard et al. 1991; Holmes 1996, 2001; Holmes et al. 1996). Research in the Nenana basin produced five excavated sites: Dry Creek, Walker Road, Panguingue Creek, Owl Ridge, Moose Creek (Powers et al. 1983; Goebel et al. 1996, Powers and Maxwell 1986, Phippen 1988, Pearson 1999a). The paucity of detailed site reports for many of these sites has made it difficult to address issues of technology, subsistence, and settlement based on the published literature. Only a few efforts have been made to produce generalizations from detailed intersite comparisons (Dixon et al. 1985; Sheppard et al. 1991; Potter 1999, 2000, 2004b).

Subarctic archaeology has been constrained by primarily natural limitations of the archaeological record. Deeply buried, stratified sites with cultural features are rare, organic preservation (of faunal remains and datable charcoal) is often lacking, and cryoturbation and other post-depositional disturbances are common. Late Pleistocene/Early Holocene stratified sites with excellent organic preservation are limited to only two sites excavated prior to this research: Broken Mammoth and Swan Point (Holmes 1996, 2001; Holmes et al. 1996; Yesner and Pearson 2002). Another Shaw Creek area site, Mead, has only received limited testing. The discovery of Gerstle River as only the third known instance of early prehistoric occupations in the Alaskan Interior with all of these attributes is therefore significant. The specific opportunities to investigate site structure and organization at Gerstle River afforded by the presence of numerous features in stratified contexts with remarkable preservation for multiple components relatively free from cryoturbation or other post depositional disturbances can be important in developing our understanding of early Alaskans.

In any cursory examination of Interior Alaskan archaeology, one critical aspect is the near ubiquity of microblade technology through the region. This technology involves the production of specialized cores for the purpose of detaching small, regular, parallel-sided blades that were used as tools in various ways (see Chapters 7, 8, and 10). This technology dates from over 20,000 years ago in Siberia to Late Holocene times in northwest North America. Given this longevity and presence in very different climatic and biotic regimes, understanding how microblades were used within a technological system and possible variations in microblade use could be useful in understanding technological change during the Pleistocene-Holocene transition and later Holocene times. Addressing site structure and organization is necessary for such an examination of microblade use.

Two observed patterns in the Alaskan Interior archaeological record have not been well addressed in the literature. First, microblade technology occurs from the very earliest components (Swan Point Cultural Zones (CZ) 4a and 4b, Healy Lake Village Chindadn) throughout the Holocene to ~1000 years ago (Lake Minchumina Level 1, BET-042, TLM-171, Healy Lake Village Athabaskan). This type of technological conservatism is quite remarkable when considering the complexity of the purported microblade-composite implement toolkit (Guthrie 1983b). Second, in sites with large excavated samples, microblade technology forms relatively localized clusters along with non-microblade clusters, such as at Dry Creek Component 2 (Powers et al. 1983), Healy Lake Village (Cook 1969), DEL-185 (Potter et al. 2000a), and Mesa (Kunz et al. 2003). While taphonomy may have impacted the latter site, relatively few question the integrity of Dry Creek Component 2. Given these two patterns, one can question the hypothesis of microblades as cultural diagnostics or a "pre-microblade" technological group, especially when considering the ubiquity of microblade technology in Siberia in the Late Pleistocene (Vasil'ev 2001; Slobodin 2001). Instead, microblades may form a part of a widespread technological system, used for specific functions or constrained by specific factors (e.g., season, prey species, armature type, distance to material source). Exploring assemblage variability is an approach that can furnish information useful for understanding the use of specific technologies.

The primary objective of this research is to investigate patterning among the lithics, fauna, features, stratigraphy, and radiometric dating, within and between components and intra-component spatial aggregates based on five years of excavation at an important Early Holocene multi-component archaeological site, Gerstle River. These analyses are all situated within and are explored in terms of technological and spatial organization. Understanding site structure and site organization of early prehistoric sites is critical to properly situate issues relating to cultural history, stability and change within foraging systems, technological organization, subsistence strategies, and settlement systems.

Identifying the organizational properties whereby sites are structured represents a fundamental avenue of archaeological research. Key frames of reference used to explore organization in this dissertation include economic anatomy of wapiti and bison (Chapter 6), technological organization and assemblage composition (Chapters 7 and 8), and patterning in spatial distribution of artifacts, features, and faunal remains (Chapters 6, 9, and 10). Inferences about mobility, curation, planning (task scheduling), and demography are produced from a contextual analytical approach (Chapters 6-11).

Each archaeological site is in some ways unique, and the strengths and weaknesses must be evaluated in order to structure the analysis to produce the best results with respect to the research questions. Components at the Gerstle River site are not particularly old, fully two thousand radiocarbon years younger than the oldest assemblages excavated thus far (Crass and

Holmes 2003). Gerstle River components lack full lithic reduction sequences (including only the latest stages of maintenance and use), have relatively few formal tools (low richness), and relatively low feature variability (absence of house pits, storage areas, middens, etc.). However, Gerstle River Component 3 has a large number of lithic raw material types, excellent stratigraphic and spatial controls, complex structure with numerous hearths, faunal clusters, and lithic concentrations, and a large sample of modified and unmodified microblades.

Rather than potentially obscuring assemblage variability by focusing on typological and essentialist concepts of technological or morphological types, I have attempted to integrate contextual classes of data in order to more fully explore assemblage and spatial organization. While the analyses presented here are a first step in documenting assemblage variability and some organizational characteristics, the lack of usewear studies that can test largely implicit hypotheses about artifact function prohibits detailed functional analyses.

The research described in this dissertation is only part of a broader research program, and can be used as a basis for further research in the context of (1) relationships among technological exaptations[2] and proxies of environmental change (e.g., ecological zonation frameworks, cf. Bigelow and Powers 2001), (2) usewear analyses (including expedient and formal tool forms), (3) examination of blade technology in addition to core morphology (cf. Owen 1988), and (4) experimental studies of various weapons platforms (composite points, bifacial points, organic points).

Problem Domains

In this dissertation, observations about lithic technology, faunal assemblages, stratigraphy, features, and radiocarbon dating are integrated within a hierarchical spatial matrix to characterize site structure and organization at Gerstle River. Examining structural patterning at a complex open-air multi-component site is a challenge; and there are numerous dimensions of variability with respect to features, lithic artifacts, faunal assemblages, and their inter-relationships. From an ethnographic perspective, myriad factors condition how hunter-gatherers use space from the level of the site and the landscape and organize their technology within a

[2] See Gould and Vrba (1982) for a discussion of "exaptation."

settlement and subsistence system (see Binford 1978b, 1983a, 1987; Kent 1984, 1991; O'Connell 1987; Whitelaw 1991; see also Simek 1989; Jochim 1976). From an archaeological perspective, we do not have a viable set of models for understanding technological assemblage variability in Interior Alaska. This dissertation examines patterned variation within technology, fauna, and features at a variety of analytical and contextual scales, and provides a series of models to explicate this variation.

Four broad problem domains, which overlap to some extent, are outlined below: documentation, technological organization, faunal assemblage patterning, and site structure and organization. Specific problem areas are detailed below along with the data used in the analysis. Given the possibility of examining site structure at a very high resolution within multiple components, considerable attention is given to assessing spatial integrity and site formation. Of particular concern are post-depositional and post-occupational disturbances that may obfuscate patterning among artifacts, fauna, and features. A variety of methods are used to assess integrity at a number of levels, including among components and within components. Radiocarbon dating offers an independent way to assess relationships among spatially defined units across a single surface or horizon. Both stratigraphic and radiocarbon controls are necessary for the detailed faunal, lithic, and spatial analyses that follow.

Documentation

At a basic level of documentation, I intend to discuss the appropriate role of research objectives in excavation design and implementation for deeply buried stratified sites in Central Alaska. Very few excavated sites have received detailed analysis and site reporting in the form of a monograph or extended site report. Our knowledge of site organization for this time period is generally poor, as a number of studies have focused on technology and cultural history within the framework of an entire site or component. In this study, hierarchically nested clusters are used to address variability at a number of levels at the site. Research questions at this basic level include delineation of components, establishment of site chronology, development of a provisional model of site formation sequence, and descriptions of technology and faunal assemblages.

The presentation of relevant data have been detailed through numerous figures and tables in order to give the archaeological community baseline data on the site and to situate analyses on site structure, faunal analyses, and technological organization within detailed contextual frameworks.

Technological Organization

Technological organization is examined on a number of levels, at the level of attribute, artifact, class, lithic raw material type, spatial cluster, larger spatial aggregates, and component. Given the artifact assemblage at Gerstle River, this analysis focuses on explicating microblades using various datasets in order to understand microblade use in a systemic context. Given the logic of this presentation, it is necessary to briefly detail the course of analysis. First, descriptive characteristics of Components 2 and 3 microblades are provided in Chapter 7. The purpose at this stage of analysis was to identify patterns among attributes, e.g., differences in metric variables, segment representation, arrises, and raw material in modified vs. unmodified microblades. Patterns in material types suggesting different modes of manufacture or functional groupings were assessed. Technological and economic analyses are presented in Chapter 8, which integrates data from slotted organic points, spatial and technological data from Dry Creek Components 1 and 2, comparisons between Gerstle River Components 2 and 3, and temporal distribution of microblade technology in Interior Alaska. Various models of microblade function are assessed against these data. Microblade patterning is examined in various spatial contexts and functional interpretations are made for microblade aggregations in Chapter 10.

Research questions examined through lithic technological description in Chapter 7 relate to classification and attribute analysis. In addition to microblades, modified flakes and burin spalls were also examined for patterning in attributes at various scales, and types were developed and integrated into spatial analyses.

Research questions in Chapter 8 involve utilization of lithic raw materials, reduction strategies, tool use, and assemblage composition. Ancillary issues include relationships between tools and debitage for each material type, identification and characterization of tool clusters, and assessment of curation and mobility. These issues are addressed through morphological and mass debitage analyses and specific tool analyses including tool formality, reuse, and tool/debitage ratios.

Research questions in Chapter 10 involve characterization of lithic spatial patterning, recognition of variation in depositional sets, and development of hypotheses that may explain the variation. Technological organization and tool use are integrated with spatial relationships among features and fauna.

Faunal Assemblage Patterning

Given the rarity of well preserved faunal remains in early prehistoric contexts in Interior Alaska (Gerstle River is only one of four sites in Alaska with this level of preservation), the opportunity for learning about this period is substantial. In order to maximize the potential for developing highly resolved models of faunal utilization at the site, I focused not only on identifiable specimens but also on unidentified fragments, which constitute large portions of most Paleolithic faunal assemblages (Klein and Cruz-Uribe 1984:17). A total of nine faunal assemblages are present at Gerstle River, and all are described (Chapter 6), however, Component 3 faunal remains were used for detailed faunal analysis.

Five related problems were addressed with respect to the Component 3 faunal assemblage, (1) spatial patterning, (2) taphonomy, (3) butchering and processing model, (4) faunal trajectories, and (5) site function. Spatial patterning among faunal remains is examined through the identification and characterization of spatially discrete faunal clusters. Evidence for areas related to primary and secondary processing and disposal are evaluated. Potential post-depositional taphonomic processes are evaluated, including carnivore and rodent modification and weathering. A spatially integrated model of butchering and processing activities is developed on the basis of spatial patterning, fragmentation, size, shape, and skeletal part frequency analysis. Expectations based on a kill-site and camp/butchering site are tested. Faunal trajectories were evaluated through models derived from the ethnographic literature and tested against the spatial patterning. Site function and its role within a settlement system is assessed using seasonality estimates, and mortality profiles. Results of these analyses are integrated with intersite data to assess food availability, diet breadth, and occupation number and size. These data are integrated with feature and lithic spatial data in Chapter 10.

The dimensional analysis of site structure presented in Chapter 11 collates all the available patterning and explores site activities, disposal modes, organization of space, locational redundancy, storage, seasonality, group size and economic structure, methods of faunal procurement, economy, and settlement system.

Site Structure and Organization

Site structure and organization can be subdivided into a number of problem areas, including lithic and faunal patterning described above. This section details specifically the issues relating to integration of normally disparate datasets. At the most basic level, archaeologists must define (implicitly or explicitly) appropriate units of analysis. Units of analysis are constrained in different ways with respect to specific research questions, e.g. technological organization, site function, activity areas, and cultural histories. This study presents a number of models for isolating technological, faunal, and spatial variables and groupings that may reflect underlying structure within each system (e.g., use and variation of microblade technology). A key issue concerning methods of identifying and characterizing structural patterns involves deciphering palimpsets. This issue can be thought of in two ways: identifying that a palimpset exists, and disentangling multiple occupations, or at least assessing the relative effects of mixture on artifacts, fauna, and features. This is achieved through a number of measures, including examination of lithic raw material distributions, tool clustering, high-resolution radiocarbon dating analysis, and testing of multiple occupation scenarios.

Each data class contributes different types of data that can be brought to bear on the problem of site structure. Each has its weaknesses and strengths. The approach taken here is to use the various data sets as independent lines of evidence to assess models of site organization. Patterning among the data is assessed through referent models derived from zooarchaeological and lithic analyses. Experimental and ethnoarchaeological datasets are used, not as strict analogs, but rather as guides to explore how variables can affect each other. A key component of the spatial analysis involves assessing the relationships among depositional sets and activity sets. The procedure taken here is to develop a number of levels of aggregation (of lithics, fauna, etc.) that can be assessed independently with respect to integrity, boundaries, palimpsets, and relationships with other aggregates. Spatial patterns are examined with respect to correspondence between tool clusters and debitage clusters, degree of homogeneity or heterogeneity within lithic clusters, assessment of feature effects, inter-hearth distances, refitting, arcs of debris, identification of depositional sets, and assessment of activity sets. Data used to address these site structural and organization questions include feature integrity and discreteness, radiocarbon dating, spatial analysis, lithic debitage and tool morphological and formal analysis, lithic refitting, stratigraphy and sediments, sediment accumulation rates, and faunal analysis. Descriptions are offered at each hierarchical level of aggregation: cluster, subarea, area, and component (see Chapter 10), and are integrated into a dimensional analysis of site structure and organization in Chapter 11.

Dissertation Organization and Guide

Given the complexity of the site, the relative lack of detailed comparative descriptions, and the intended documentation objective, this dissertation is relatively large. This section describes the dissertation organization and offers a guide for readers. This dissertation is divided into eleven chapters; and it can be approached in a number of ways. Chapters 1 through 3 provide environmental and cultural background to the site and the research problems. Chapters 4 through 9 provide detailed data and analyses on specific data classes, stratigraphy and sediments (Chapter 4), radiocarbon dating (Chapter 5), faunal remains (Chapter 6), artifacts (Chapters 7-8), and features (Chapter 9). Each of these chapters is relatively self-contained, and each one has an introduction, methods, results, and discussion. This dissertation has been organized so specialists can examine each data class independently or in conjunction. Chapters 10 and 11 present spatial and dimensional analysis, respectively, and both integrate lithics, features, and faunal data. These two chapters are based in part on analyses presented in Chapters 4 through 9, especially Chapter 8. Each chapter is briefly described below.

Site orientation and history of research at Gerstle River is presented below. Chapter 2 details the research excavation objectives and excavation protocols. Horizontal and vertical controls, excavation methods, stratigraphic profiles, and curation are discussed. Chapter 3 describes the site setting, including environmental and cultural background. Regional physiography and climate, glacial and bedrock geology, soils, sediments, vegetation, and modern fauna distributions are summarized. Using data from various palynological studies, the paleoenvironment of the region is summarized. The history of disturbance at the site is discussed, and a reconstruction of the site area prior to disturbance is produced.

Lower Locus stratigraphy and sediments are described in Chapter 4. Through various sediment and stratigraphic analyses, a provisional model of site formation is produced. Post-depositional processes are evaluated, and the spatial integrity of the lithic and faunal artifacts from the various components is examined. Stratigraphy, radiocarbon dates, and assemblages between the Lower and Upper Loci are correlated. This chapter provides the geomorphic context within which to assess the integrity of archaeological components.

Radiocarbon dating results from the Lower Locus are detailed in Chapter 5. Expectations based on stratigraphic and contextual factors are discussed. Scales of analysis, radiocarbon dating methods, and possible sources of variation in radiocarbon ages are evaluated. The results are assessed with respect to site chronology and occupation history. Component 3 occupation episodes, spans, and scenarios are discussed.

Faunal assemblages from Gerstle River Lower Locus are described in Chapter 6. Spatial distribution, weathering, fragmentation, articulation and refitting, skeletal part frequency analysis, age and sex estimation, and gastroliths are analyzed. Post-occupational and post-depositional taphonomic processes are evaluated. Hunting and butchering behaviors are discussed, faunal trajectories are proposed, and a faunal processing spatial model is developed for Component 3. Other faunal assemblages are described and briefly examined.

The lithic and organic artifacts recovered at the Lower Locus are described in Chapter 7. Classification and specific attributes are discussed, and lithic raw material types are described and examined with respect to abundance and use. Due to specific research questions relating to microblades, metric and non-metric attributes are analyzed for patterning. Analysis at this level relates to differences between modified and unmodified microblades and among attributes.

Technological and economic analysis of lithic artifacts are presented in Chapter 8. Mass and morphological debitage analyses are presented. Microblades from Components 2 and 3 are examined in the context of composite tools, comparisons with assemblages from Dry Creek Components 1 and 2, and various models of microblade use are examined. Technological organization is investigated through raw material use, assemblage composition, curation, and lithic reduction stages. Site function is assessed on the basis of the lithic assemblages.

The features at Gerstle River Lower Locus are described in Chapter 9. Hearth morphology is described and faunal remains situated within each feature are analyzed and compared. Associated floral taxa from flotation and macrofossil analysis are described. Feature use scenarios are constructed on the basis of hearth morphology and associated fauna and tools. This chapter also presents detailed illustrations of tools, debitage, and faunal remains within the drop zones of each feature. These figures and supporting descriptive data can be consulted when reading the spatial analyses (Chapter 10) and dimensional analyses and interpretation (Chapter 11).

Spatial analyses of lithics, features, and fauna are detailed in Chapter 10. Results of refitting and other analyses at a number of aggregate levels are integrated. Spatial variations in lithic raw material use, tool distributions, variation in microblade production, feature drop and toss zones, and spatial association among lithic and faunal remains are used to describe and interpret the spatial organization at Component 3.

The patterns and analyses within Component 3 are described in the Chapters 4-10 are assessed through a dimensional analysis of site structure and organization in Chapter 11. Intrasite dimensions include activities, technological organization, disposal modes, organization of space, locational, site structural, and compositional redundancy, storage facilities, seasonality, and ecological and topographic location. Dimensions with an intersite component include group size and economic structure, methods of faunal procurement, economy, and settlement system.

Site Orientation

The spatial and historical complexity at the Gerstle River site necessitates a brief orientation to the site, including component designations and various hierarchical levels of spatial designations used in this dissertation. The site is located on a southern knob of a bedrock hill rising 137 meters above the surrounding outwash plain one mile east of the Gerstle River, a large braided river in the middle Tanana basin (Figures 1.1-1.3). Surrounding vegetation is typical bottomland spruce forest, though the southern exposures contain some xeric taxa. Past quarrying activity by the Alaska Department of Transportation and Public Facilities has destroyed much of the site (see below). The Gerstle River site area is illustrated in Figure 1.4. Gerstle River is composed of two distinct and geomorphically separate loci, the Upper Locus, where most of the previous work was conducted, and the Lower Locus, the focus of this dissertation. Sixty horizontal meters and fifteen vertical meters separate the loci, and they are oriented to different directions and viewsheds. The Upper Locus has a southeast aspect and the Lower Locus has a south-southwest aspect. These two loci are discrete, with a slope of over 30° between them, and they should be considered as essentially separate sites for the reasons stated above.

The Upper Locus excavation is comprised of seven excavation blocks of varying sizes excavated by Kotani in 1983 and 1985 (Kimura et al. 1989), labeled *Grids A* through *G* and five 2 m^2 test pits excavated by Holmes in 1996 (Holmes 1998a) designated *Test Pits 1* through *5*.

Further spatial differentiation at the Upper Locus is unnecessary here (Appendix A and Potter 2002).

The Lower Locus excavation (1999-2003) is comprised of various spatial elements, from largest to smallest: *Excavation Block*, *Excavation Unit* (EU), and *quadrant (quad)*. Excavation blocks were labeled alphabetically and designated incrementally during each field season (Blocks A through AA) (Figure 1.5). Blocks typically contained four 1 m^2 excavation units, but could vary based on the research design each year. Each block contained its own series of subdata, and field specimen numbers were assigned incrementally within each Block. Excavators were typically assigned to a block, and would alternate digging among the 1 m^2 EUs within each block by level. Each EU was labeled according to its southwest origin, e.g. N43E55. This facilitated redundancy in artifact provenience and labeling, as each artifact would be physically referenced within each EU and the site as a whole (e.g., EU N43E55 would be comprised of all materials between N43.00-43.99 and E55.00-55.99). The EU was the level of x-y provenience when skim shoveling and screening the upper sterile sediments. Each EU consisted of four 50 x 50 cm (0.25 m^2) quads. This was the basic unit of provenience for screened materials in the artifact-bearing strata, and the basic analytical unit for debitage and fauna.

Because the excavation depth varied for each block, the total excavated area varied by component. A total of 111 m^2 were excavated through the disturbed sediments during the 1999-2003 excavations. A total of 107 m^2 were excavated through Components 3, 4, and 5 (strata Y4a and Y3), 86 m^2 were excavated through Component 2 (stratum Y4b), and 77 m^2 were excavated through Component 1 (stratum Y5a). An additional 2 m^2 test pit (Block W) was excavated to the west of the main site, but the stratigraphy in this block has yet to be linked to the main stratigraphic model. In 1996, a 1.5 m^2 test was excavated along the bluff edge, at approximately N46E32 and N45E32 (labeled *Bluff Test Pit*, Holmes 1998a).

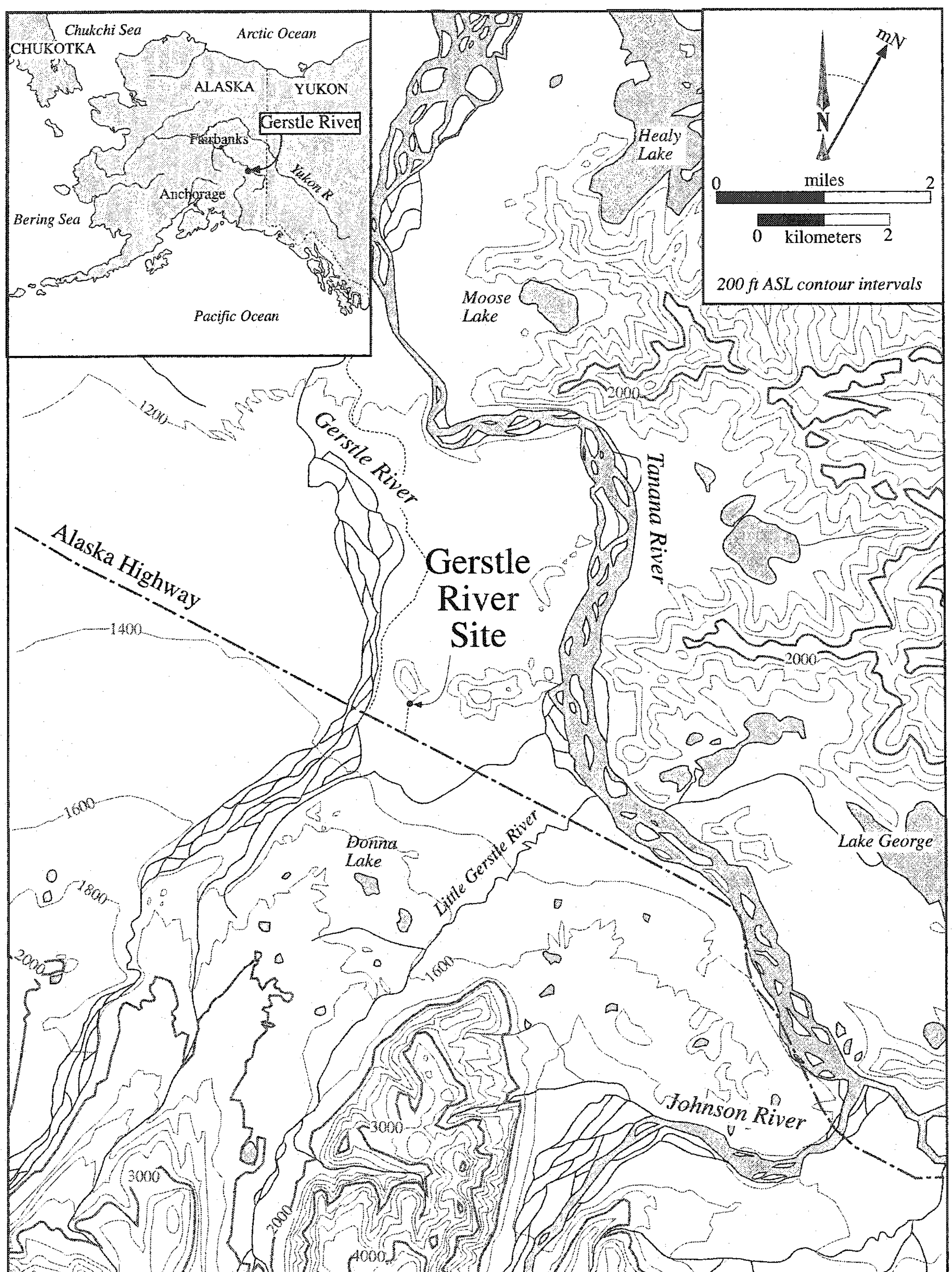

Figure 1.1 Gerstle River location (base data from USGS 1975).

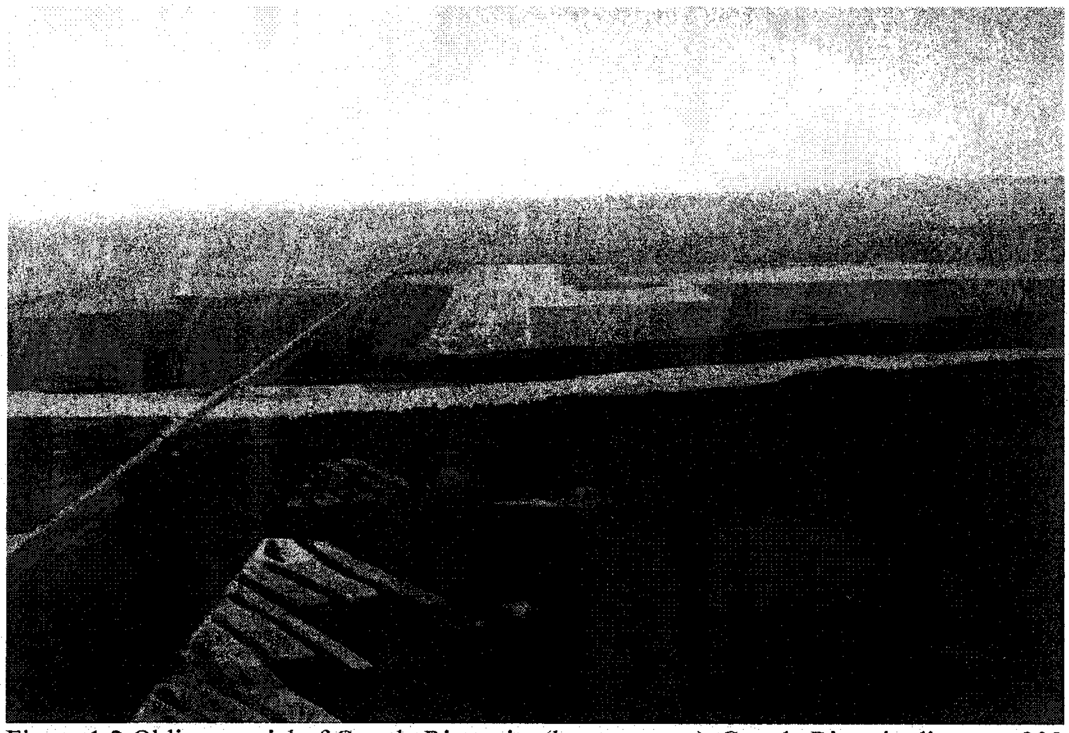

Figure 1.2 Oblique aerial of Gerstle River site (lower center), Gerstle River in distance, 2001, view northwest.

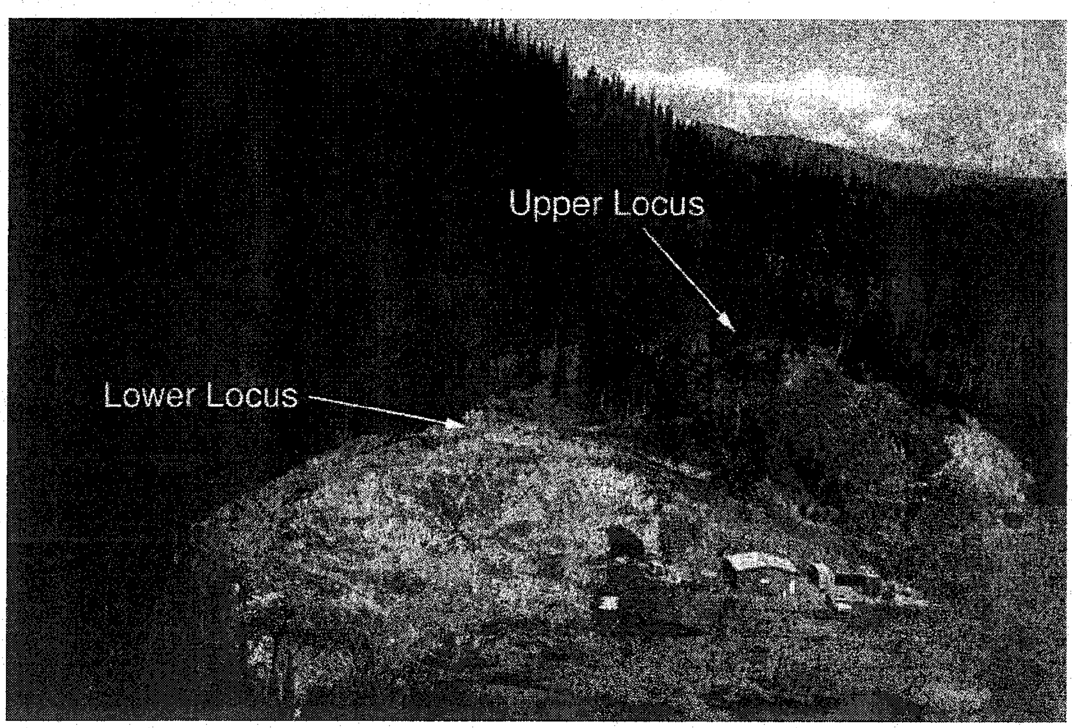

Figure 1.3 Oblique aerial of Gerstle River site, 2001, view northeast.

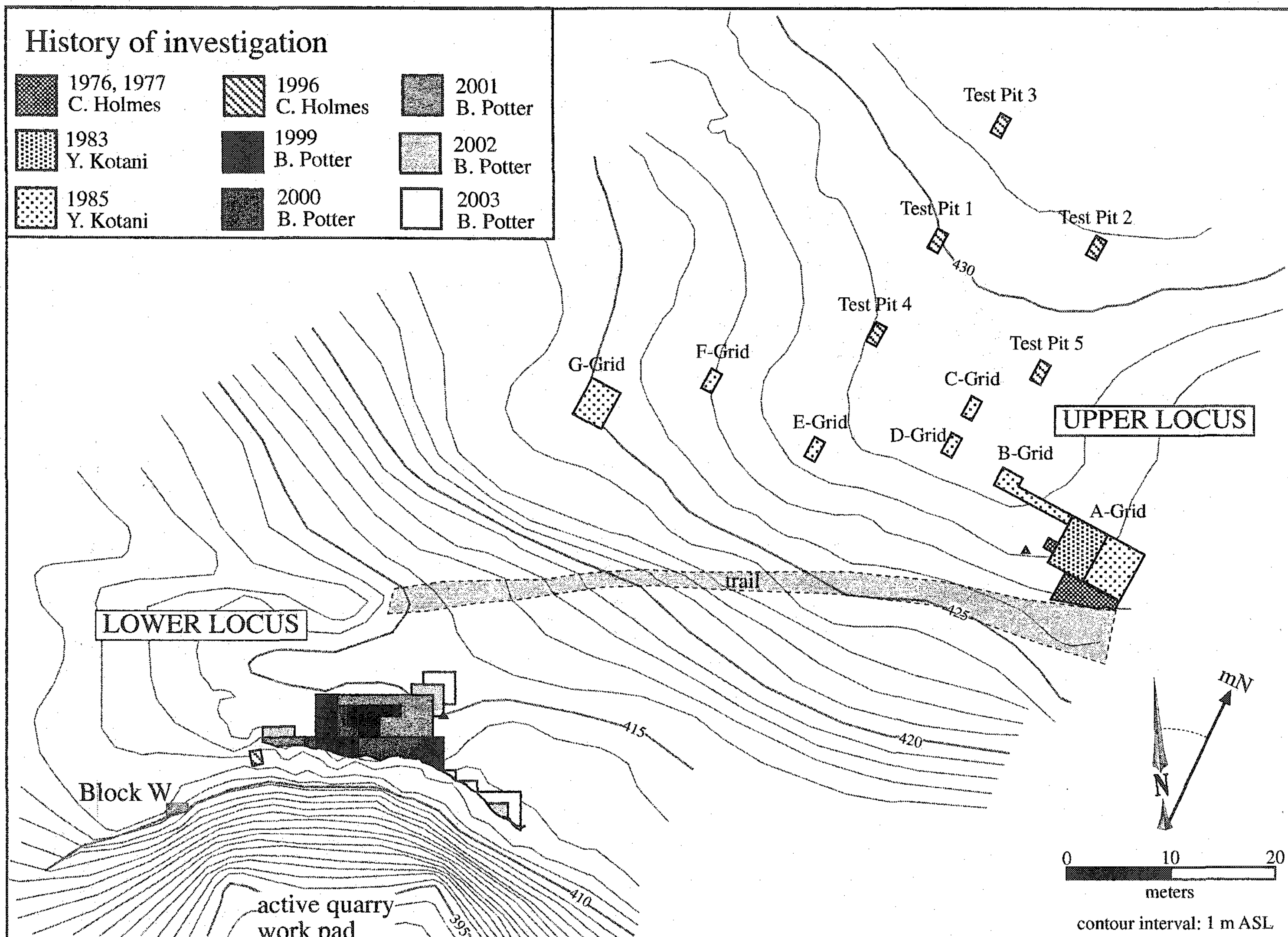

Figure 1.4 Gerstle River site map.

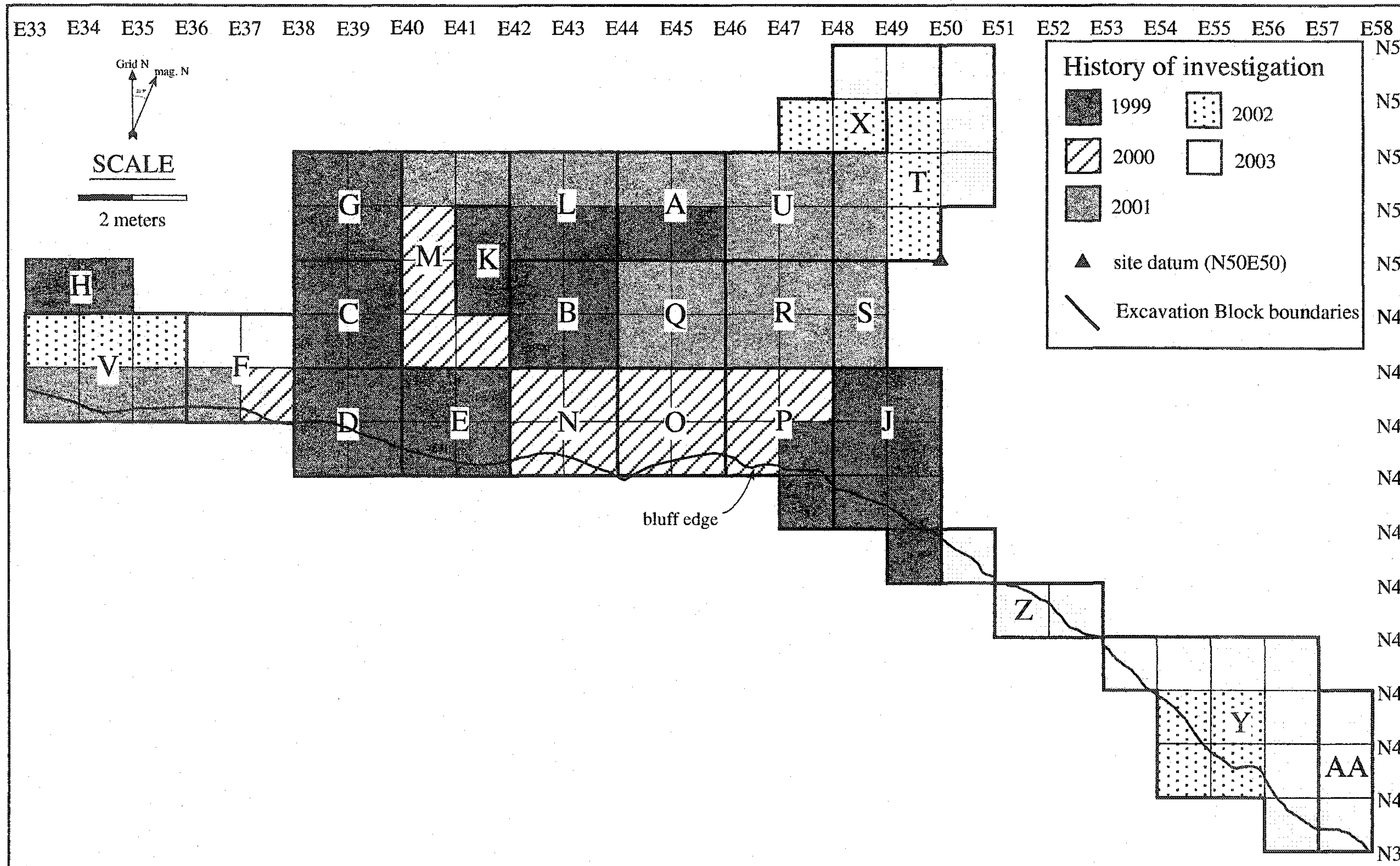

Figure 1.5 Lower Locus site grid.

Seven cultural components are represented at the site, four from the Upper Locus and five from the Lower Locus. The earliest is Component 1, which is associated with a pebble layer within stratum Y5 just above paleosol 1 (P1) about 75 cm below the bottom of stratum R4 at the Lower Locus. Component 2 is associated with two hearths and one cobble feature (Features 2, 17, and 19) within stratum Y4b, about 35-45 cm below the bottom of stratum R4 and 10 cm below stratum R5. Component 3 is associated with ten hearths (Features 1, 3, 5, 9, 10, 12, 13, 14, 16, 18) and two charcoal scatters (Features 8 and 11) within stratum Y4a, about 15-25 cm below stratum R4 and about 6 cm above stratum R5. Component 4 is associated with one hearth (Feature 7) within stratum Y4a, about 8-10 cm below stratum R4. Component 5 is found within stratum Y3, above stratum R4. Component 6, associated with stratum Y2 and Component 7, associated with stratum Y1 are not present at the Lower Locus, and are only found at the Upper Locus (see Chapter 5 and Potter 2002).

Nomenclature

This dissertation includes a number of separate analyses, integrated by the research questions outlined above, including faunal, lithic, and spatial analysis. For the sake of clarity, terminology relating to various groupings is defined here. *Category* refers to a grouping variable, similar to artifact class, used in artifact classification and description (Chapter 7). *Group* is a general term used when a typological or technological grouping is tentative, such as various groups of modified microblades and modified flakes (Chapters 7 and 10). *Spatial aggregates* or *aggregations* refer to all the various hierarchical levels of spatial groupings, including (in descending order of area) *site*, *locus*, *component*, *area*, *subarea*, and *cluster* (Chapter 8). *Assemblage* refers to archaeological materials (faunal or lithic) at various levels of groupings based on stratigraphy (component), spatial (component, area, subarea, cluster) or technological grouping (specific category, such as microblades). Components are defined on the basis of stratigraphy and radiocarbon dating (see Chapters 4 and 5). Lithic areas and subareas are defined on the basis of spatial aggregation and segregation of lithic materials within components (see Chapter 10). Lithic clusters are designated by material type and location; thus *CmR1b* is the second cluster of gray rhyolite (R1) in Area C (see Chapters 7 and 10). Faunal clusters are designated as *cluster F1*, *F2*, etc. (see Chapter 6).

Excavation Description (1999-2004)

The Gerstle River site has been investigated by several researchers since its discovery in 1976 by Charles Holmes (Holmes and Dilliplane 1976). A history of investigation of the Upper Locus is provided in Appendix A, describing the artifacts, features, radiocarbon dates, and interpretations as presented in their reports or in original field notes. This section describes the investigations initiated at the Lower Locus by the author from 1999 to 2004. Table 1.1 provides a timeline of the various investigations at the Gerstle River site. A total of 96 m^2 has been excavated to date at the Upper Locus, and 112.5 m^2 has been excavated at the Lower Locus, 111 m^2 as a result of this investigation.

Prior to 1999, only one test pit was excavated at the Lower Locus, though cultural remains were observed on the surface during previous years (see Appendix A, Figures A.5-A.6). Holmes found bone fragments, gastroliths, one flake, and one microblade fragment in this test, associated with stratum Y4a with bracketing dates of 10000 and 8300 BP (Holmes 1998a:10).

Table 1.1 History of site investigations (1976-2003).

Date	*Reference*	*P.I.*	*Locus*	*Area (m^2)*	*UAM Accession*
summer, 1976	Holmes and Dilliplane (1976)	Charles Holmes	Upper	~3	UA77-55
6/8/1977 – 7/4/1977	Rabich and Reger (1978)	Charles Holmes	Upper, collection at Lower surface	12	UA77-55
7/13/1983 – 8/5/1983	No site report. Kimura et al. (1989)	Yoshinobu Kotani	Upper	20	UA83-52
7/23/1985 – 8/9/1985	No site report. Kimura et al. (1989); Kotani (n.d.), original strat. profiles and plan maps	Yoshinobu Kotani	Upper	51	UA85-134
7/8/1996 – 9/16/1996	Holmes (1998a), original strat. profiles	Charles Holmes	Upper, Lower Test Pit	12	UA97-61
6/1/1999 – 7/29/1999	This dissertation (see also Potter 2001a, 2002)	Ben A. Potter	Lower	35	UA99-62
6/7/2000 – 7/4/2000	This dissertation (see also Potter 2001a, 2002)	Ben A. Potter	Lower	16	UA2000-54
5/29/2001 – 6/24/2001	This dissertation	Ben A. Potter	Lower	28	UA2001-71
9/13/2002 – 9/28/2002	This dissertation	Ben A. Potter	Lower	12	UA2002-62
5/29/2003 – 7/2/2003	This dissertation	Ben A. Potter	Lower	20	UA2003-54

1999 Excavation

I became involved with the Gerstle River site in the Spring of 1999, when Charles Holmes (of the Alaska State Office of History and Archaeology) encouraged me to investigate the Lower Locus' archaeological potential. At this point, all that was known was that there were *in situ* materials likely dating to the early Holocene period, but the quantity and quality were largely unknown. This work resulted from a cooperative agreement between the newly formed Delta Mine Training Center (DMTC) which proposed to excavate a practice mine in the bedrock below the Lower Locus and the Delta-Greely School District (D-GSD), which were sponsoring a work program for exceptional high school students from the local area. The DMTC planned the project to train local residents in mining technology in anticipation of a gold mine located near Pogo. The general feeling was that the archaeological work (1999) would merely document the archaeology at this Lower Locus prior to anticipated disturbance by DMTC and continuous disturbance by Alaska DOT. I was hired to develop a research design and excavation plan and to implement and direct the excavations at Gerstle River. An ancillary goal was to assess the site's legal significance and archaeological potential with respect to Section 106 of the National Historic Preservation Act of 1966. With the assistance of Whit Hicks (director of DMTC), Judy Hicks (teacher at D-GSD) and five high school seniors and juniors, the site was excavated between June 1 and July 29, 1999.

There were three main obstacles to mitigate prior to excavation. One was the overburden or spoil (0.5 – 2.0 m thick) that had been deposited from further south from the former hill location south of the site area and deposited on top of the Lower Locus. Another problem was the dangerous slope on the southern edge of the site (Figure 1.7). The bluff edge was approximately 60°, and consisted of loose rubble for about 20 m to the bottom of the slope. The most important problem, however, was the presence of very large granite boulders directly over the excavation area, some measuring over 3 m in diameter (Figure 1.6). With the generous support of Whit Hicks, a large excavator and D7 bulldozer were used to create a bench below the bluff edge as a working platform with a berm on the outside edge for the safety of the workers (Figures 1.6-1.9). During this process, the excavator reached out from the top of the bluff to remove just enough sediment to allow the D7 to create a bench along the bluff edge. The spoil piles were placed in three groups on top of the site, (1) a series of piles representing the best chance of recovering artifacts from this process (i.e., the lower undisturbed sediments from the bluff edge), (2) a large pile representing undisturbed sediments, and (3) a large pile representing the uppermost undisturbed sediments and the spoil. Much of the "best" piles and some of the "medium potential" pile were screened between 1999-2001, but no lithics or faunal fragments was recovered from these piles. Ironically, a few cultural items were recovered from the "low potential" pile. These few flakes and bone fragments were likely from the disturbed overburden, as numerous items were discovered in this layer during the excavation (see Chapter 7). During later seasons, artifacts and bone were found eroding from the latter two piles.

Once the bench was established, the bulldozer and a large excavator was used to remove the large boulders and to peel back the overburden until undisturbed sediment was reached. Holmes and I monitored the process until we discerned undisturbed sediments (primarily in Blocks T and X to the northeast). Even with this check, there was still between 0.25 to 0.75 m of overburden above undisturbed sediments in most of the other excavation areas.

The first step in deciding where to place the excavation grid was digging a sequence of auger holes on top of the Lower Locus area to determine depth of the overburden. The auger probes revealed spoil to between 1.23 m and 0.03 m of spoil at different areas of the bluff edge. The final grid placement was determined by the location of the 1996 Holmes Bluff Test Pit (for the western limits) and the recovery of a green chert flake from a lower component (later Component 1) (for the eastern limits). I decided on a checkerboard pattern of 2 m^2 Blocks (A, B, C, D, E, F, G, H) in order to maximize artifact recovery and spatial coverage of the site area. Once a series of three Blocks were excavated to R4, I extended one into a 6 m long trench oriented perpendicular to the E-W bluff edge (Blocks C, G, F). When ungulate tooth enamel and black chert flake (C4) were found to be eroding further east of the initial Blocks, I initiated a new Block (J) in this area. Upon the discovery of Feature 1 and numerous associated faunal and lithic items, I expanded Block B to attempt to recover items associated with this hearth feature (Blocks K and L). Given time constraints and the deep sediments, only one EU was excavated to bedrock (Block E, EU N47E41). The Block H excavation was halted after the bottom of the overburden was reached due to the cultural materials in Blocks B and C, and because the depth of sediments increased dramatically from east to west (e.g., R4 was 0.75 m below surface [BS] in Block B, 1.25 m BS in Block C, and 1.5 m BS in Block V, adjacent to Block H). As this block did not continue past the disturbed overburden, it is not included in the excavation area totals[3]. I also decided to only excavate the two southern EUs in Block A due to time constraints for the 1999 season. The remaining two EUs were later excavated in 2001.

A total area of 35 m^2 was excavated to varying depths. Twenty-six m^2 were excavated to below the artifact-bearing layers (Y4 level 6), the remaining nine m^2 were excavated to below the main artifact bearing layers (Y4 level 2). All excavation blocks were protected with clear plastic sheeting and packed sediment, partially backfilling the units. Ending elevations were 0.6 to 0.9 m below the bottom of R4 (BR4) in the main excavation Blocks, 0.9 m BR4 in the trench (Blocks D, C, G), 1.5 m BR4 in Block E, except for EU N47E41, excavated to a depth of 3.5 m BR4 (Figure 1.10).

The 1999 excavation resulted in the documentation of three cultural components, two of them below the lowest component found by Holmes in 1996 (1998). Each of the upper two components had an associated firepit feature and the uppermost (Component 3) also had numerous identifiable bone fragments. The components were stratigraphically separated, and yielded rich lithic assemblages. Component 3 materials included 8 burin spalls, 1 burin, 1 short axis beveled flake, 3 facet rejuvenation flakes, 136 unmodified microblades, 1 microblade core fragment, 4 microblade core tablets, 10 modified flakes, 36 modified microblades, 1 spall scraper, 796 unmodified flakes, and 246 faunal lots. Component 2 materials included 6 burin spalls, 3 facet rejuvenation flakes, 83 microblades, 5 microblade core tablets, 1 modified flake, 13 modified microblades, 364 unmodified flakes, and 2 faunal lots. Component 1 was represented with only a dozen flakes and one small bone fragment. Possibly *in situ* materials associated with the contact between the overburden and R1 include 1 biface fragment, 1 short axis beveled flake, 1 modified flake, 27 unmodified flakes, and 9 faunal lots. Four bone fragments were found within stratum Y3. Items from disturbed contexts included 1 burin, 1 short axis beveled flake, 1 hammerstone, 5 microblades, 3 modified microblades, 1 modified flake, 1 spall scraper, 10 flakes, and 22 faunal lots. A total of 1204 UA Museum catalog numbers were assigned (UA99-62).

The checkerboard approach allowed a view of stratigraphy for 6 m E-W and 5 m N-S. The main cluster of artifacts for both components occurred on a nearly horizontal area (as

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[3] Two of the excavation units in Block H were later excavated as part of Block V (EU N49E33, EU N49E34).

inferred by the slope of R4 and P1), and did not extend (with the exception of a few bone fragments) beyond a definite slope trending east-west apparent in the stratigraphic profiles of Blocks E and D (north walls).

Initial lithic and faunal analyses were conducted in the winter of 1999-2000, including radiocarbon dating the two hearths and paleosol 1, faunal analysis, and detailed tool and debitage analyses on Component 2 and 3 materials. These ^{14}C dates, of 8860 BP on Feature 1, 9510 BP on Feature 2, and 9740 BP on paleosol 1, were consistent with the radiocarbon dates at the Lower Locus and placed the components in the earliest Holocene.

As the Lower Locus contained deeply buried stratified sediments with multiple cultural components, with datable material, diagnostic artifacts, features and well preserved faunal remains of locally extinct animals in association with features and other cultural remains, I decided to make Gerstle River Lower Locus the focus of my Ph.D. research. Immediately, plans were made to investigate this site more fully during the next few field seasons. Given the clear significance of the site, I worked closely with Whit Hicks, who still planned to excavate an adit below the site, to protect the archaeological site.

Figure 1.6 Surface of the Lower Locus, 1999, view west (note large granite boulders).

Figure 1.7 1999 bench construction, view east.

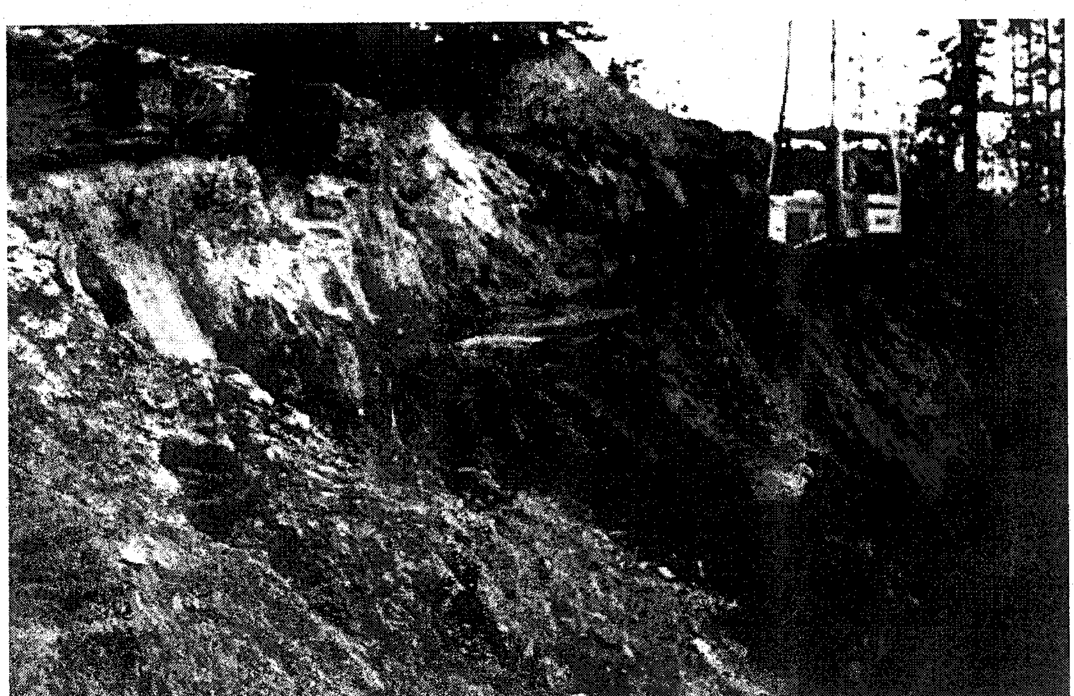

Figure 1.8 1999 bench construction, view east.

Figure 1.9 1999 Lower Locus prior to excavation with completed bench and grid, view west.

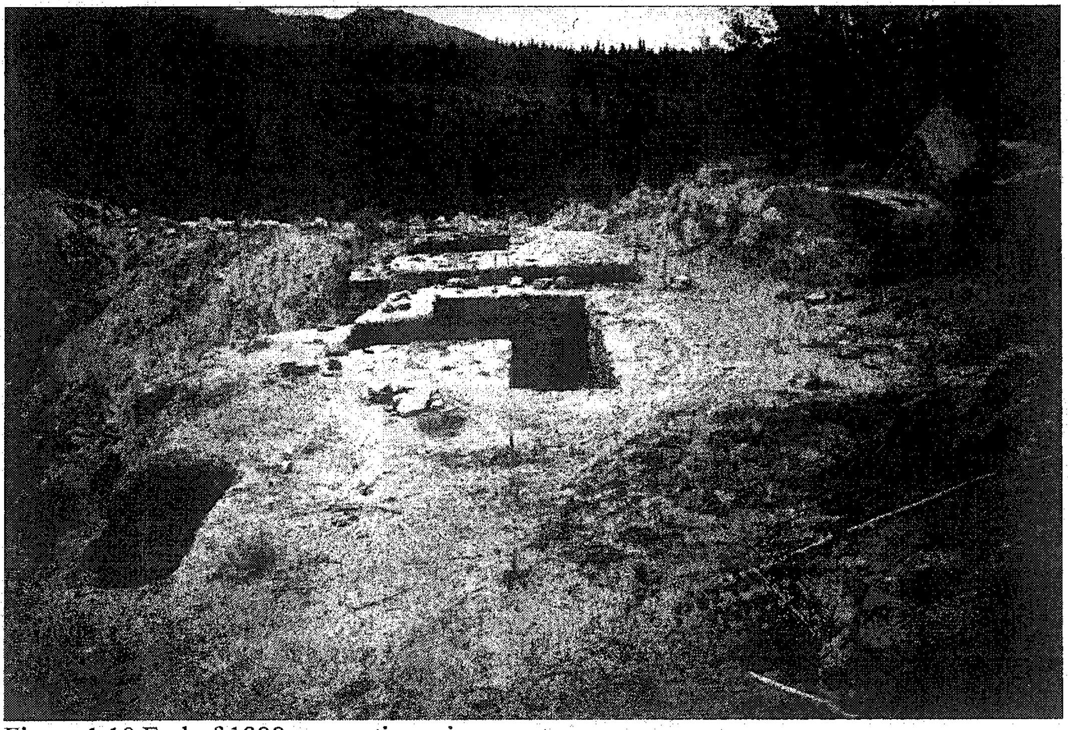

Figure 1.10 End of 1999 excavation, view west.

2000 Excavation

I had originally planned a field school for the summer of 2000, to be sponsored by UAF. However, lack of student interest forced a scale-back of those plans. Two students, one taking the excavation as an independent study, aided me in limited excavations that year. Fieldwork took place between June 7 and July 4, 2000 (Figures 1.11-1.13). A crew of from two to four workers excavated the site. The field crew consisted of the author, Marcus Bingham, and Jennifer Newton. Charles Holmes graciously aided in the excavation for a few days.

Of the research objectives planned for this year (see below for details), the single most important was to (1) stabilize the southern edge of the site prior to bluff edge slumping or collapse, and (2) link the artifacts and faunal remains recovered in Blocks B and J. The material in Block J resembled a bone dump feature with disarticulated faunal remains and few lithics. The faunal remains in Blocks A, B, K, and L were primarily articulated and associated with numerous lithics. Understanding the spatial relationships was critical in interpreting Component 3 activities and site structure. Both of these objectives were obtained by excavating a 6 x 2 m area between these Blocks.

The Alaska DOT had removed a large part of the western portion of the bluff in the Spring of 2000, leaving a dangerous edge about 10-15 m tall. The immediate excavation area was not damaged. The DMTC had begun the mine tunnel in below the site, but this did not appear to disturb the sediments above. A number of faunal fragments and flakes were found eroding from the bluff edge between Blocks E and J; these were photographed and recovered.

At the beginning of the excavation, I noticed a slump in Block N (~3.5 m^2), that fell between May 11 and June 7, 2000. Thaw cracks were appearing in Block M pedestal and in Block O. The slump area was mapped as well as where the debris was situated relative to its source. The materials were screened in order to get approximate x-y data (within 1-2 m). Only 3 microblades and 13 flakes (all of gray chert (C1)) and no faunal remains were recovered from the Block N slump. Thus, this disturbance did not affect component assignment or spatial analysis in adjacent areas. We immediately excavated the remaining portion of Block N, and in fact were able to reconstruct x-y-z data on artifacts and fauna immediately after another smaller slump in EU N46E44 given that the material fell as one block with straight edges. Block M was also excavated during this season, but yielded few artifacts.

As Block F was in danger of slumping, the remaining EU was excavated. A *Cervus* innominate fragment and another bone fragment were found, suggesting another cultural area of Component 3 west of the main concentration of Components 2 and 3. At this point, Blocks P and O were excavated in order to create a stable southern wall to the site in anticipation of future work in 2001. The exposed bluff edge was in danger of collapse throughout our excavation in Blocks N, O, and P. In this area, two new hearth features were uncovered (Features 3 and 5). The former was found bisected by the bluff edge, with the southern half already eroded out (Figure 1.11). The latter hearth continued to the north and was drawn with the primary east-west profile (eventually extending 16 linear m). A number of diagnostic artifacts and faunal remains were found next to the bluff edge. In Blocks N, O, and P, about 40 cobbles ranging in size from 6 cm to 15 cm were recovered. These cobbles were associated with a pebble-rich sand about 65-75 cm below the bottom of R4, and just above Paleosol 1 (P1), which was weakly represented in this part of the site (discontinuous, about 1 cm thick). The matrix upslope and downslope of the large cobbles showed no difference in accumulation of pebbles or sediment characteristics. Most of the cobbles were horizontal, but some lay skewed at angles between 10 and 60°. The edge of the pebble-rich sand layer was reached in EU N46E46. Ending elevations for 2000 were 0.7 m BR4 in Blocks N, O, P, 0.4 m BR4 in Block M, and 0.3 BR4 in Block F.

A total area of 16 m^2 was excavated to varying depths in 2000. In addition, 9 m^2 were continued from the 1999 excavation. All units were excavated to below the artifact bearing layers (below Paleosol 1). All excavation blocks were protected with clear plastic sheeting and packed sediment and large rocks. The 2000 excavation resulted in the further documentation of two cultural components (Components 1 and 3) and produced the first clear evidence of a new component overlying Component 3, designated Component 4. Component 4 materials included 24 unmodified flakes and two faunal lots. Two additional Component 3 hearth features (F3 and F5) were excavated. Component 3 materials included 1 biface fragment, 6 burin spalls, 1 facet rejuvenation flake, 79 microblades, 2 microblade core tablets, 1 modified flake, 15 modified microblades, 1 long axis beveled flake, 2 spall scrapers, 861 unmodified flakes, and 117 faunal lots. Component 1 materials included 1 modified flake, 287 unmodified flakes, 6 bone fragments, and 44 medium to large cobbles potentially representing a large feature. Two faunal fragments were recovered from stratum Y3. Items from disturbed contexts included 9 microblades, 23 unmodified flakes, and 61 faunal lots. A total of 822 UA Museum catalog numbers were assigned (UA2000-54).

Given the data recovered thus far, I completed a Determination of Eligibility for the site in May 2001, and the State Historic Protection Officer (SHPO) concurred, and Gerstle River is considered potentially eligible for the National Register of Historic Places. This site clearly meets the legal requirements under Criterion D, potential to yield information useful for prehistory, given deeply buried stratified sediments, multiple cultural components in stratified contexts, organic preservation, typologically and technologically diagnostic lithic artifacts, preserved faunal remains of locally extinct animials, and features and associated patterning in cultural materials.

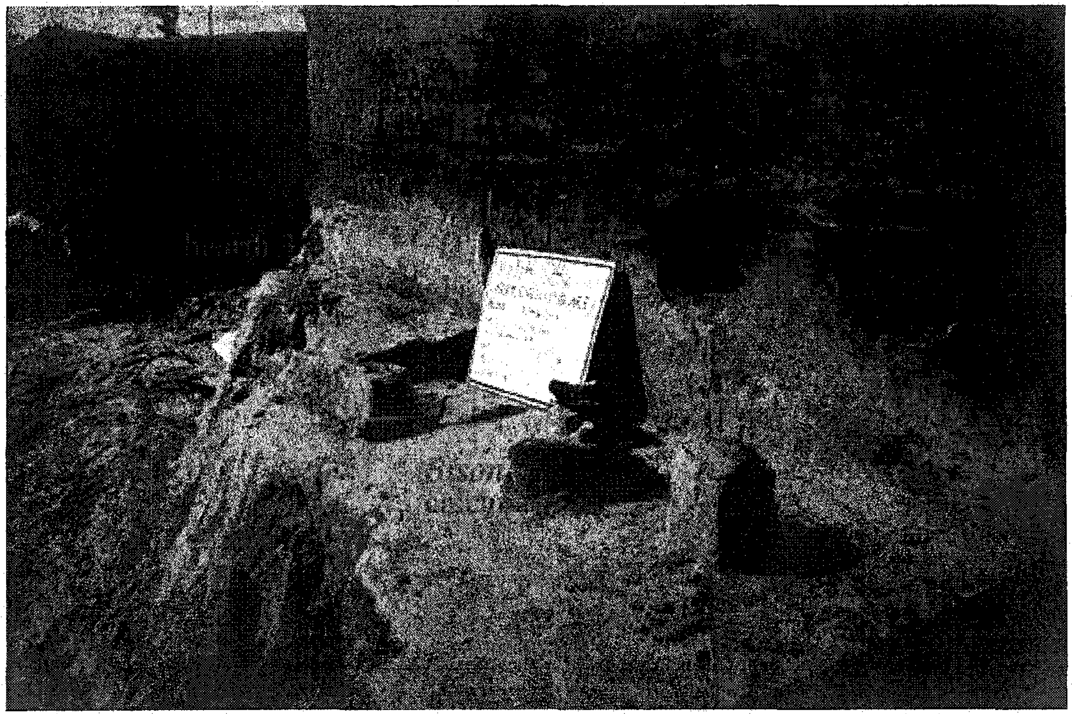

Figure 1.11 2000 excavation, Feature 3 and associated fauna and tools at bluff edge, view northwest.

Figure 1.12 2000 excavation, view west.

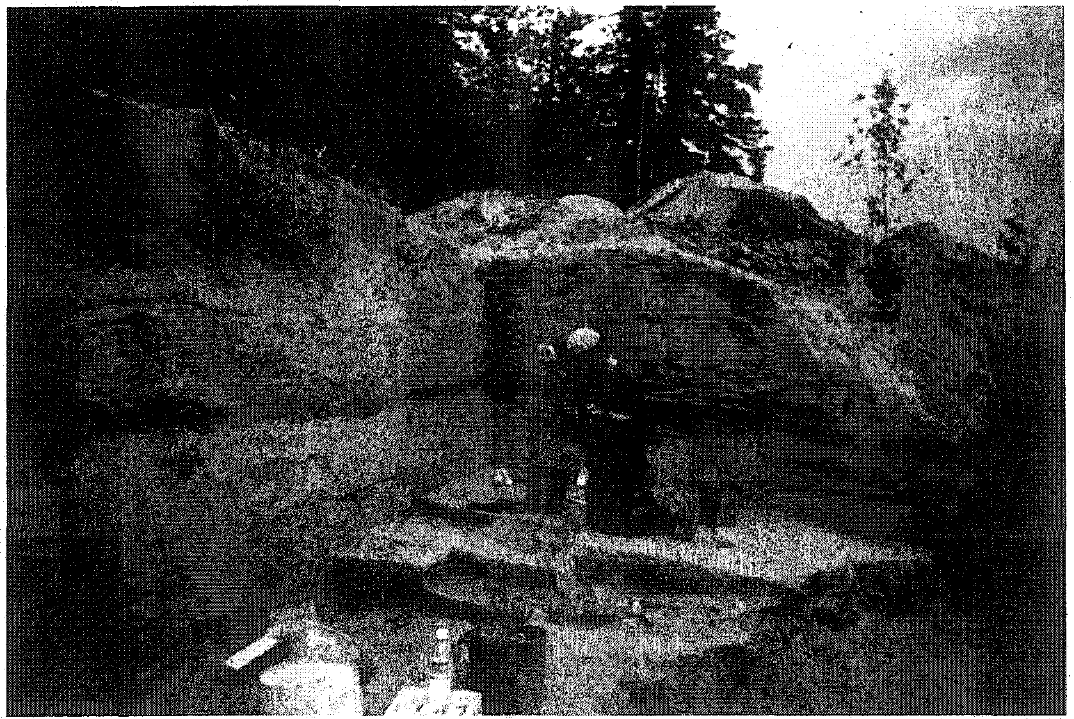

Figure 1.13 2000 excavation, view east.

2001 Excavation

In 2001, I led a UAF-sponsored field school of limited duration, from May 29 to June 15, with additional excavation with a volunteer crew from June 15 to June 24 (see Figures 2.2-2.5). Nine students were enrolled, and an additional three high school students from the D-GSD Youth Initiative helped with the excavation. Of the nine students, all six from in-state volunteered for the later excavation. Our goal in 2000 of stabilizing the southern edge of the site was successful, and no slumps had occurred in the intervening winter and spring breakup. With the addition of a total station to our equipment through the generous donation by NLUR vice president Peter Bowers, I mapped the surrounding site area, including several points at the Upper Locus.

The primary goals (detailed below) were to excavate the southwestern edge of the bluff (Block V) before it collapsed and to document any cultural materials associated with the innominate found in 2000 in Block F, excavate adjacent units between the 1999 and 2000 work to delineate the site structural relationships between these areas (Blocks A, B, K, L and Blocks J, N, O, P), to excavate the northern half of Feature 5, to determine the nature of the large cobbles encountered in Component 1 in 1999 and 2000, and to recover radiocarbon samples for this component. I also planned the excavation in the main site area to have a square outline as to minimize the danger of collapse and further erosion. Given these considerations, a block excavation measuring 4 m n-s and 6 m e-w was implemented. The 1999 grid was extended to incorporate Block V, directly south of Block H, where the bluff edge was in danger of slumping. As an experiment, all 3-point measures would be taken with sub-datum method (metric tape and line level) and with the total station, offering a comparison of their efficacy (see below). Excavation methods are detailed below.

A total area of 28 m^2 was excavated to varying depths in 2001. In addition, 3 m^2 were continued from the 2000 excavation. A dense activity area between the 1999 and 2000 excavation areas was delineated, with the discovery of three hearths and two charcoal scatters and associated artifacts in two components (Components 3 and 4). In addition, a new cultural area in Component 3 was found in Block V, located seven meters to the west of the main artifact concentration areas. No charcoal or associated features were discovered within Component 1. All units were excavated to below the artifact bearing layers (below Paleosol 1). All excavation blocks were protected with clear plastic sheeting and packed sediment and large rocks after excavation.

The site produced a large quantity of cultural remains from Components 1, 2, 3, and 4. A large hearth feature (Feature 7), 1 modified blade, 3 unmodified flakes, and 13 faunal lots were associated with Component 4. Three new Component 3 features were discovered, including two hearths (Features 9 and 10) and two charcoal scatters (Features 8 and 11). Component 3 materials included 6 burin spalls, 4 facet rejuvenation flakes, 358 unmodified microblades, 1 microblade core fragment, 4 microblade core tablets, 7 modified flakes, 31 modified microblades, 1 long axis beveled flake (convergent side scraper), 2 spall scrapers, 1174 unmodified flakes, seven gastrolith clusters, and 182 faunal lots. A microblade core tablet, burin spall, 6 unmodified microblades, 5 flakes, and tiny bone fragments were recovered from Component 2. The Component 1 sample was greatly increased, with the recovery of 1 projectile point base, 1 biface fragment, 2 modified flakes, 1647 unmodified flakes, and 5 bone/enamel fragments. Fifty-four medium to large cobbles were also recovered in stratigraphic association with Component 1. The increase in spatial information was rewarding, as several potential activity areas were completely excavated and two new areas were identified, one to the extreme northeast (Block T) and the other to the extreme west (Block V). A single bone fragment was discovered in stratum Y2 and four bone fragments were recovered in stratum Y3, but still no artifacts were associated with these strata. Thirteen faunal lots were recovered from unknown contexts within Block W, situated on the bench edge about ten meters west of the excavation. Items from disturbed contexts included 1 biface fragment, 2 hammerstones, 2 microblades, 1 microblade core fragment, 1 modified flake, 2 long axis beveled flakes, three spall scrapers, 77 unmodified flakes, and 47 faunal lots. A total of 1594 UA Museum catalog numbers were assigned (UA2001-71).

Analyses were conducted in the winter of 2001-2002, including a radiocarbon-dating program for each of the undated cultural features (n=5). These analyses showed that Feature 7 (8660±40 BP) was indeed younger than the Component 3 hearths that lay stratigraphically below it (Features 1, 3, 5, 9, 10, 11). The Component 3 hearths were remarkably uniform in their distribution (8890±40 BP, 8910±40 BP, 8950±40 BP) and consistent with the Feature 1 date. A charcoal scatter in Block T (Feature 8) yielded a date of 9130±40 BP, which was significantly older (see Chapter 5). Therefore, the future excavation objectives related to expanding excavation in this area in order to expose the entire activity area associated with this charcoal scatter.

2002 Excavation

While a larger effort was planned for the 2003 field season, a small volunteer excavation was conducted from September 13 to 28, 2002. The 2002 excavation consisted of a volunteer effort between September 13 and September 24, with a brief visit on September 28 (Figures 1.14-1.15). Over 25 people took part in this volunteer excavation, including students from UAF Fundamentals in Archaeology class and archaeologists working at Fort Greely in the summer. The objectives were to continue excavation of southwestern edge of the bluff prior to collapse (Block V), determine the nature of the occupation or component associated with Feature 8 in Block T, dating to perhaps an earlier period than the other hearths, and further investigate the possibility of a lower component. The majority of artifacts and features recovered in 2002 related to Component 3, but Component 4 was noted in Block Y, where artifacts were found ~8 cm above Component 3. A conical microblade core was found exposed in the eroding bluff edge about nine meters southeast of the main cultural areas. A new Block (Y) of ~3 m^2 was opened around this core, yielding numerous wapiti faunal elements, microblades and debitage, and two new hearth features (Features 13 and 14). Continued work in the northeast area (Blocks T and X) yielded a large well-defined hearth (Feature 12) and numerous faunal and lithic remains. Block V sediments were screened and piled against the eroding bluff edge immediately west of Block V, to help shore up the edge.

A total area of 12 m^2 was excavated to varying depths in 2002. All units were excavated to below the main occupation layer, Y4 level 2. Due to safety considerations, and after discussions with the DMTC Director, Whit Hicks, an orange safety fence was installed around the perimeter of the site in order to protect the site. Three new Component 3 hearth features were discovered (Features 12-14). Component 3 materials included 10 burin spalls, 1 burin, 1 short axis beveled flake, 1 facet rejuvenation flake, 320 unmodified microblades, 1 microblade core, 3 microblade core tablets, 15 modified flakes, 30 modified microblades, 2 spall scrapers, 1020 unmodified flakes, and 158 faunal lots. Component 4 materials included 1 burin, 1 unmodified microblade, 8 modified flakes, and 5 unmodified flakes in Block Y. Three bone fragments were recovered within stratum Y3. Items from disturbed contexts included 1 burin spall, 1 endscraper, 7 microblades, 4 modified microblades, 1 microblade core, 2 spall scrapers, 16 unmodified flakes, and 7 faunal lots. Additional items include 4 hearth matrix samples and 41 radiocarbon samples. A total of 963 UA Museum catalog numbers were assigned (UA2002-62).

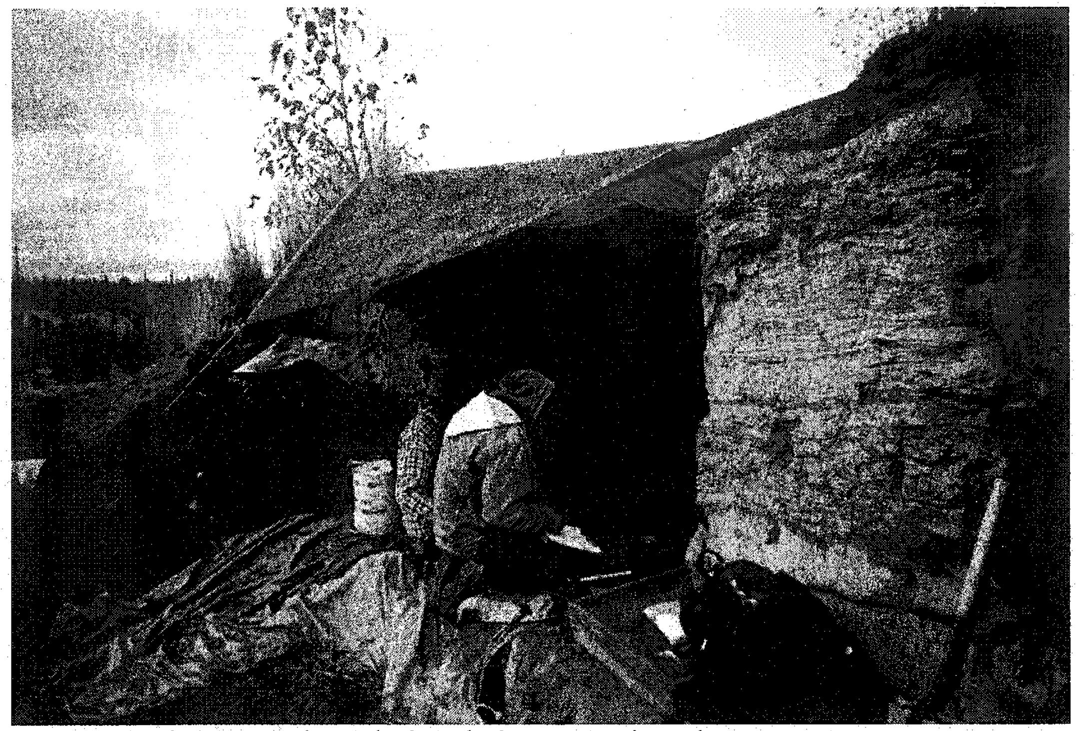

Figure 1.14 2002 excavation, Block V during excavation, view west.

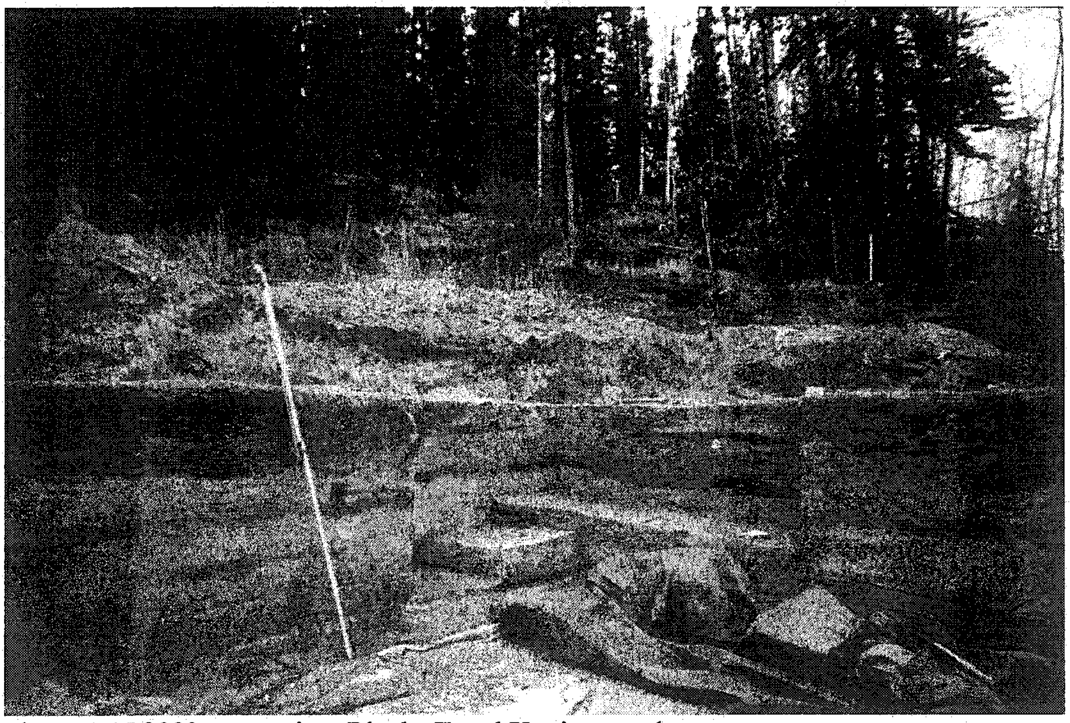

Figure 1.15 2002 excavation, Blocks T and X, view northeast.

2003 Excavation

Although a large excavation was not funded, I implemented a limited field school sponsored by UAF Summer Sessions, consisting of five students from May 30 to June 14, 2003 (Figures 1.16-1.18). The excavation crew was composed of nine volunteers, mainly archaeologists working in nearby Fort Greely. In addition, sixteen archaeologists from Fort Greely aided in testing the lower sediments on May 19, 2003. An Austrian film crew filmed the continued excavation of 3 m^2 at the edge of Block Y on July 26, 2003. The primary objectives for the 2003 season was to (1) further delineate the activity area in Block Y, (2) test the lower sediments for earlier archaeological materials, (3) profile the stratigraphy of the lower sand to bedrock contact, and (4) to further delineate the activity area in Blocks T and X.

Due to safety considerations, a 16 m^2 block was opened initially (Blocks O, P, Q, and R), as these were already excavated below paleosol 1, and were away from high walls. This large block was stair-stepped to allow ease of entry and exit and stabilize the sandy walls during the excavation. Thus, a total of 8 m^2 was excavated to bedrock, 5 m^2 were excavated to the top of the gray sand, and the remaining 3 m^2 were excavated in a stair fashion (each m^2) to allow exit from the block. All walls were profiled. During the initial excavation on April 10, a number of green chert (C5) flakes were recovered, clearly from Component 1. The presence of these flakes below the main Component 1 group suggested post-depositional disturbance, i.e. vertical displacement. Therefore, adjacent areas were excavated an additional 20 cm in order to recover any Component 1 materials that were below the main Component 1 group. Only a few flakes were discovered, suggesting this displacement was relatively localized and that Component 1 was fully recovered in other areas. Continued excavation in the lower sediments yielded a single undiagnostic bone fragment and no cultural remains. Given the unstable nature of the lower sand, I backfilled the 16 m^2, ~2 m deep block, and piled sediment adjacent to Block V.

After this phase of the 2003 excavation, attention turned to delineating the activity areas in Blocks T, X and Block Y. A series of units was excavated on the bluff edge in order to expose the area between Block J and Block Y (these units were labeled Block Z). Only a few lithics and a few bone concentrations were noted. Excavations in Blocks T and X revealed another Component 3 hearth (Feature 18) and a dense cluster of lithics and faunal remains. Excavations in Block Y revealed another Component 3 hearth (Feature 16), and the presence of a lower component within stratum Y4b (below R5) stratigraphically correlate with Component 2, in the form of a hearth (Feature 17) and a cobble feature (Feature 19) with numerous associated lithics. A new component (Component 5) was recovered within Y3 (below R3b) in Blocks Y and Z, with associated lithics and faunal remains.

New areas of 20 m^2 were excavated to varying depths. In addition, 21 m^2 were continued from the 2002 excavation. All units were excavated to below the main occupation layer, Y4 level 2, and 8 m^2 were taken to bedrock. Results included further documentation of Components 1 and 3, the discovery of another Component 2 hearth feature, cobble feature, and associated cultural materials, and the discovery of a new component within stratum Y3, designated Component 5. Component 5 materials included 86 unmodified flakes, 1 manuport, and 7 bone fragments. Two new Component 3 hearth features were discovered. Component 3 materials included 1 biface, 2 burin spalls, 1 burin, 2 refitting short axis beveled flake fragments, 317 unmodified microblades, 1 microblade core, 1 microblade core fragment, 5 microblade core tablets, 34 modified flakes, 22 modified microblades, 4 spall scrapers, 1740 unmodified flakes, and 173 faunal lots. Component 2 materials associated with Features 17 and 19 include 1 burin spall, 1 short axis beveled flake, 2 modified flakes, 1 spall scraper, 336 unmodified flakes, and 1 enamel fragment. Component 1 materials included 1 burin spall, 88 unmodified flakes, and 5 faunal lots. Eleven articulated bone fragments from a wapiti lower limb were found in stratum Y2 in Block V, but no artifacts were found in association. Items from disturbed contexts included 4 microblades, 1 modified microblade, 2 modified flakes, 1 spall scraper, 8 unmodified flakes, and 3 faunal lots. A total of 1513 UA Museum catalog numbers were assigned (UA2003-54).

Due to ongoing high precision sensors placed around the site by DMTC, the sediments were not disturbed by backfilling in 2003. Planned areas of future work are (1) the Component 3 activity area in Blocks T, X, and (2) the southeastern areas with materials from Components 2, 3, 4, and 5 in Blocks Y, Z, and AA.

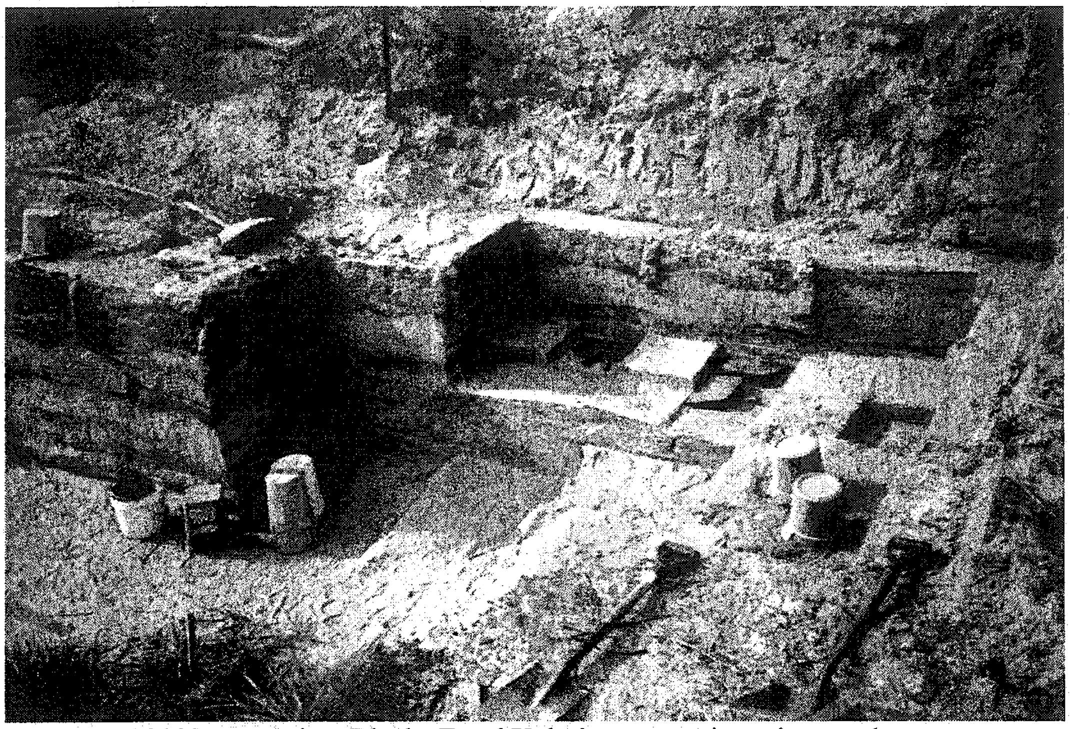

Figure 1.16 2003 excavation, Blocks T and X during excavation, view north.

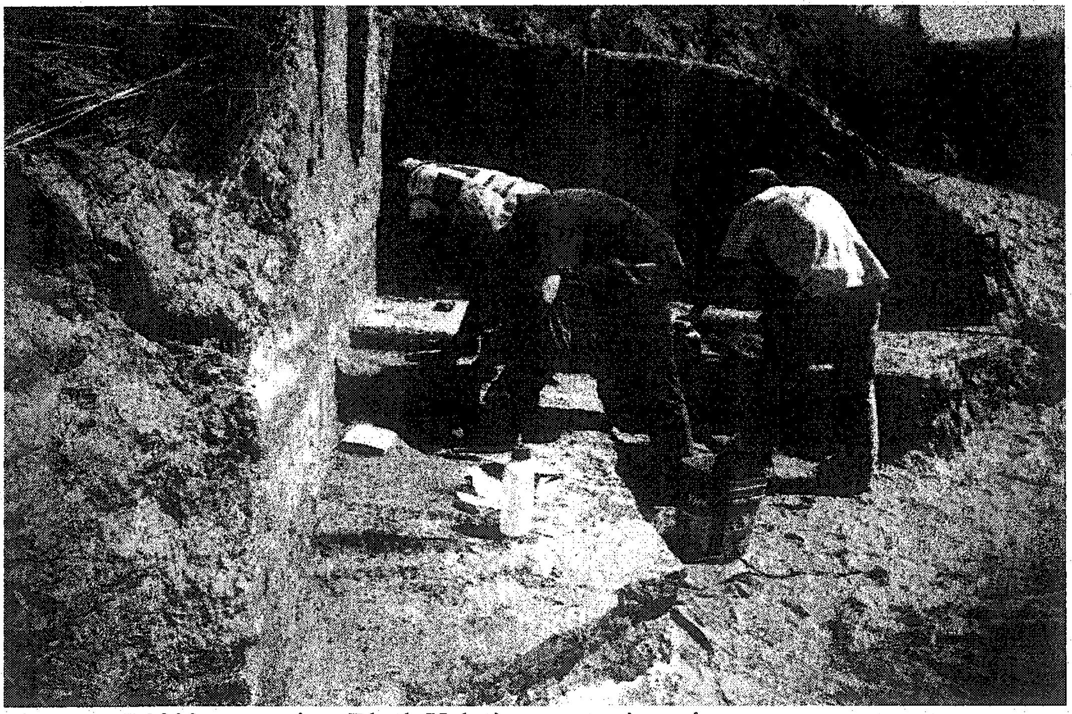

Figure 1.17 2003 excavation, Block Y during excavation, view east.

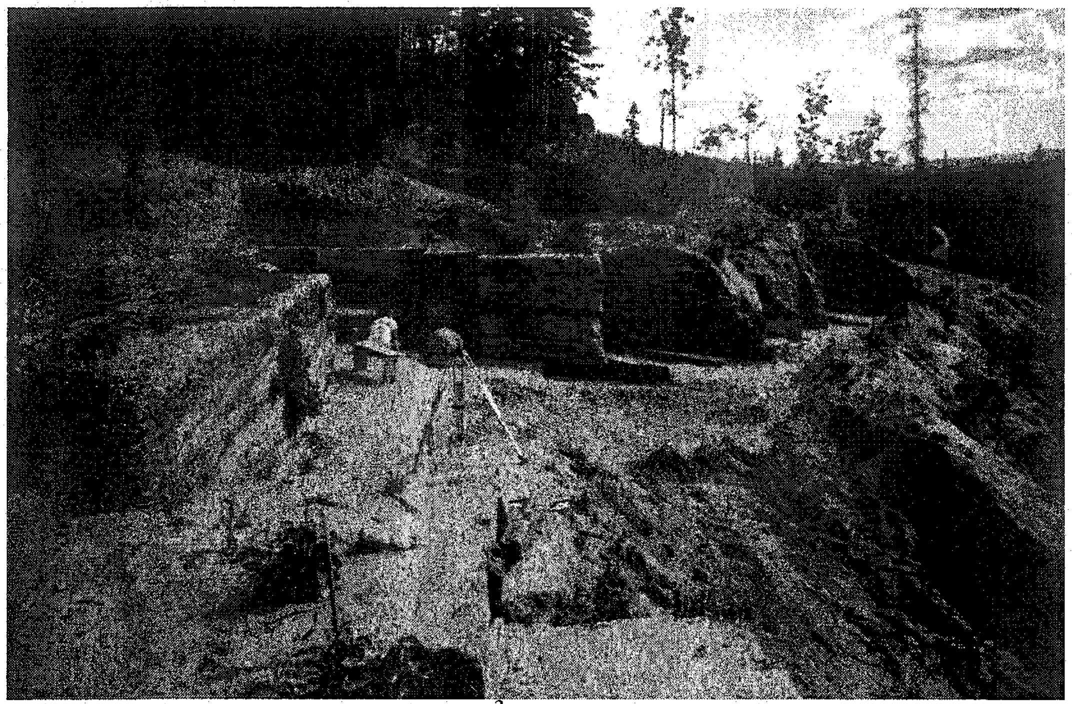

Figure 1.18 End of 2003 excavation, 16 m^2 backfilled area beyond the tripod, view east.

On July 8, 2004, with the aid of Whit Hicks, director of DMTC, the majority of the site (essentially the open excavation west of Block Q) was backfilled (Figures 1.19-1.20). Heavy plastic sheeting (8'4" wide by 0.006" thick was placed at the bottom of the excavation in all areas except Blocks V, Y, and Z (Figure 1.19). Using an excavator and a D-5 bulldozer, we initially removed the extensive overburden from the unexcavated area directly east of Block T and north of Block Z. We graded that area, removing the overburden and stopping when undisturbed sediment was reached in one spot. There is an estimated 5-30 cm of overburden still capping this area. We then removed the backdirt and disturbed overburden northeast of Block X. Once this area was taken down to within 20 cm of the undisturbed, this material was pushed over the north excavation wall to backfill the site (Figure 1.20). The area between the existing excavation and the road up the hill to the north has been cleared of most of the overburden. Disturbed overburden from the western portion of the hill, west of the site area was pushed over the edge of the eroding bluff to protect the face and remaining natural sediments. This procedure continued up to the Block V area. In this way, a protective layer of disturbed sediment is present from the furthest west portion of the estimated site area to approximately East 44 on the site grid. DMTC plans to replant grass to spur regrowth in the area of backfilling. The only areas remaining open are Blocks X and T, along with an access route, and Blocks J, Y, and Z to the east.

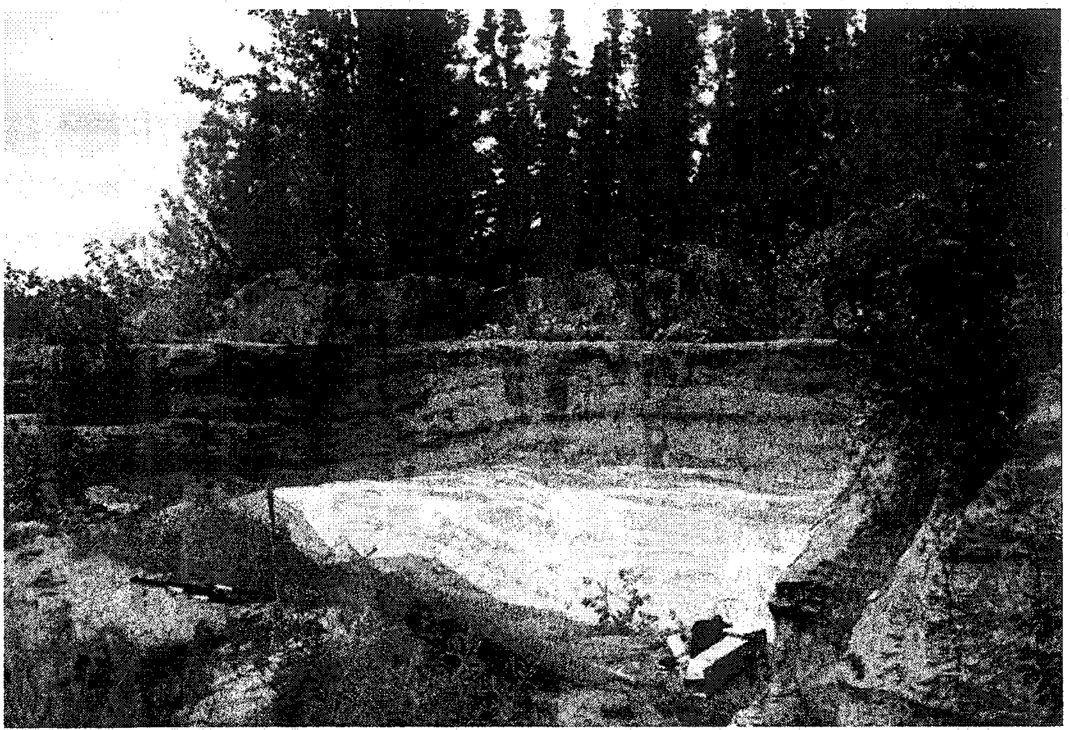

Figure 1.19 Site prior to backfilling, base of excavated area, view northwest.

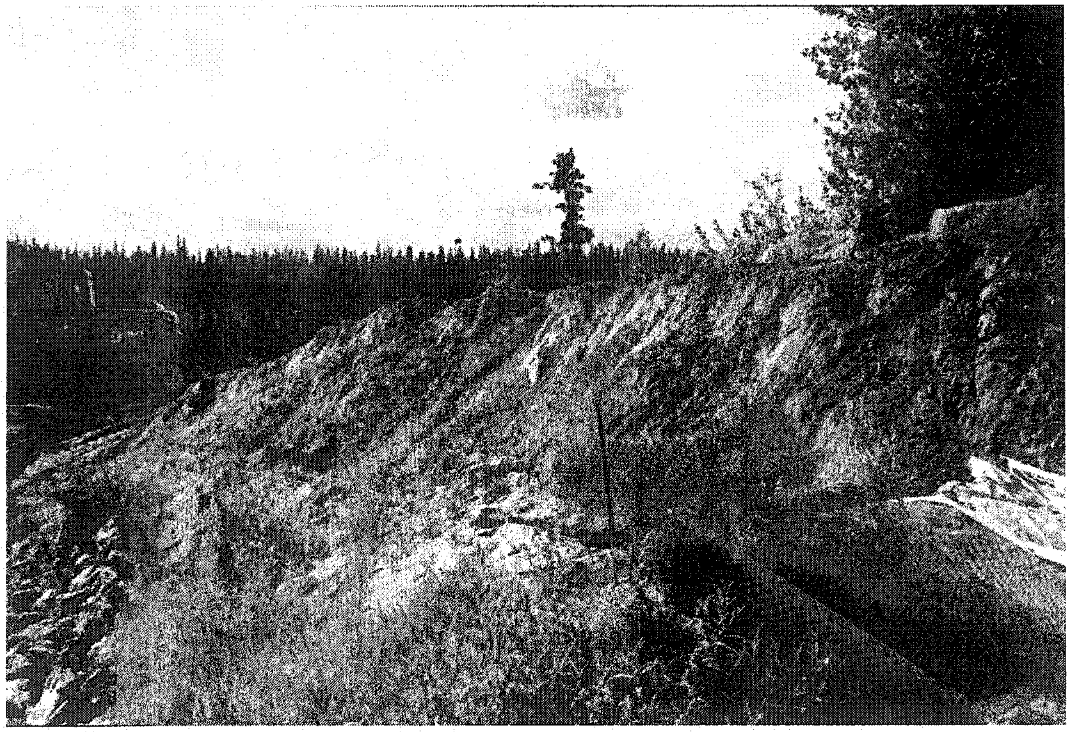

Figure 1.20 Site backfilled, view west

Chapter 2. Research Design

Excavation Objectives

The research objectives are divided into analytical objectives, which form the theoretical and methodological framework for this dissertation, and objectives relating to the excavation of the Gerstle River site, which includes specific objectives for each of the years of work. Analytical objectives were detailed in Chapter 1, and excavation objectives are described below.

Excavation of archaeological sites, particularly buried prehistoric sites, should not be undertaken lightly. They constitute international cultural resources that are destroyed through excavation. With respect to our current understanding of Interior Alaskan archaeology, large-scale excavations should be undertaken with caution, and only with a clear research orientation linking research questions with appropriate excavation methods.

From one perspective, the excavations at Gerstle River have been of a salvage nature. The danger of artifact and feature displacement and destruction due to aeolian deflation is high, greatly exacerbated by fifty years of quarrying activities. Numerous diagnostic faunal elements and tools have been noticed eroding from the Lower Locus from the first discovery of the site in 1976 (Holmes and Dilliplane 1976). Indeed, during my excavations from 1999-2003, we recovered features, lithic artifacts, and faunal remains in immediate danger of being lost (see Figures 1.11 and 9.6).

Since the removal of the bedrock knob immediately south of the site in 1995 this erosion has accelerated (see Chapter 3). Stabilization efforts would be expensive and the nature of the deposits and archaeological material at the Lower Locus was not established prior to my investigation in 1999 (see below). The primary purpose of the 1999 excavation was to assess the nature and condition of the archaeological remains at the Lower Locus. Specific objectives included determining the extent of artifact distribution(s), the significance of the archaeological material, eligibility of the site area for the National Register of Historic Places, the depth of sediment overlying bedrock, the number of archaeological components, retrieving radiocarbon-datable material to date the occupation(s), and mitigating the site prior to its use as a mine training site. When faunal remains, lithic tools and debitage, and associated hearth features were found, the excavation objectives were modified during subsequent years. The site of course was not considered mitigated given the nature of the archaeological finds. Subsequent excavations further developed and expanded the original objectives.

The most significant change in scope was after the initial 1999 excavations. The recovery of numerous lithic artifacts, articulated and disarticulated faunal remains, all in association with well-defined features in stratigraphic contexts increased the research potential for this site. The research focus transitioned from basic questions about the archaeological remains present to specific questions related to potential activity area utilization, relationships among features, components, faunal remains in various stages of articulation (e.g., remains in Block B vs. Block J), and other site structural or organizational queries. However, basic issues of site stabilization and data recovery given the constant aeolian erosion remained important throughout the years of excavation.

In 2000, the main objectives were to excavate the southeastern edge of the bluff (Subarea B2) before it slumped and collapsed, excavate adjacent units to the 1999 activity areas (Subarea B1) to expand the artifact sample, collect artifacts eroding from the bluff edge before their provenience was lost, link Block J with the main excavation area in order to investigate the relationship with the fauna in the former with the lithic remains in the latter, determine if there is a pattern to the large cobbles encountered stratigraphically associated with Component 1 in 1999.

The objectives for 2001 were to excavate adjacent units between the 1999 and 2000 work to delineate site structural relationships between these areas, excavate the northern half of Feature 5, determine the nature of the large cobbles encountered in Component 1 in 1999 and 2000, excavate the southwestern edge of the bluff before it collapsed and to document any cultural materials associated with the innominate found in 2000 in Block F, and to secure a square outline in order to minimize potential slumping and to protect the southern edge of the site.

In 2002, the objectives were to continue excavation of southwestern edge of the bluff prior to collapse (Block V), determine the nature of the component associated with Feature 8, dating to perhaps an earlier period than the other hearths, and further investigate the possibility of a lower component.

In 2003, the objective was to methodically examine the relationships between the hearths located in 1999-2002 and the surrounding artifacts. Because some of the hearths (F12, F13, and F14) were only excavated in 2002, it was imperative to open up adjacent areas to determine spatial patterning of the artifacts and fauna. The presence of another area on the bluff face (Block

Y, discovered in 2002 about 7 m southeast of the main site) required a closer examination of the intervening area of the bluff edge. In addition, two of the hearths (Features 13 and 14) continued into unexcavated areas. Their exposure to the elements necessitated data recovery in 2003. A large cobble feature (Feature 6) found in Component 1 also continued into the northern unexcavated section. Given the current interpretation, it was possible that significant parts of it remained unexcavated. Finally, it was hoped that we could excavate the eroding bluff edge between Blocks J and Y, leaving a solid face to form a protective southern edge to the site. Unfortunately, I did not have enough personnel to fully achieve this goal by the end of the 2003 season, but the main part of the site was backfilled in 2004, leaving the eastern portion open for further work.

Excavation Protocols

Detailed descriptions of the excavation protocols are necessary in order to understand the presentation and interpretation of the archaeological data from this site. Information on how vertical and horizontal provenience was controlled and how the site was documented during its excavation are provided below.

Given the salvage nature of the project, a balance had to be maintained between precision of the provenience data and speed of recovery[1]. The excavation strategy was designed to: (1) facilitate the examination of relationships of artifacts, faunal remains, and potential activity areas, (2) sample the potential variability that may have existed as a function of distance from the bluff edge and distance from the hearth centers, and (3) address artifacts eroding in several places.

Site Datum and Grid

In 1999, a site datum was established at what was assumed to be the eastern edge of the site given the local terrain, and later positioned using a high precision Trimble ™ GPS unit. The site datum is located at 144°53'17" W longitude and 63°49'16" N latitude (using WGS 1984

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[1] In May 2000, an area of the bluff edge between Blocks B and E (largely within Block N) collapsed during the spring thaw. In early May 2001, a series of thaw cracks were observed in Block Q bluff edge, requiring speed in excavation prior to collapse.

horizontal datum) and at 420 m ASL. The site datum was placed about 20 m east of the 1996 test pit and five m back from the bluff edge in 1999, on the highest relatively flat terrain at the Lower Locus. A metric grid was established over the lower locus with the aid of a transit and steel tape, with grid east-west oriented parallel to the eroding bluff edge to avoid awkward excavation unit edges at the bluff face. This resulted in grid north being 22.5° west of magnetic north. The grid measured 20 m east to west and 8 m north to south, covering an area of 160 m^2, in anticipation of the area for excavation. In 1999, the transit was used to develop an elevation map of the immediate lower locus area and the surrounding work pad. We also mapped the position of R4 where it was exposed along the bluff edge. In 2001, a total station was used to acquire elevation data linking the lower locus, upper locus, surrounding work pad, and the current gate for the DMTC.

The datum point was established as N50E50, and an E-W baseline was laid out. This baseline consisted of wooden stakes every placed every 2 m. From this baseline, the corners of the Excavation Blocks (4 m^2) were established with metal spikes. The Blocks were labeled alphabetically as they were laid out, and each was divided into four 1 m^2 excavation units (EU). Each 1 m^2 EU was identified by the grid coordinate of its southwest corner. Horizontal provenience was established by measuring from the south and west, yielding an N value and an E value, e.g., N48.59, E36.22. From this value, we know that the item must have come from EU N48E36, for an added layer of redundancy. Elevation measures were initially taken for each corner point of each EU. As additional areas were excavated in succeeding years, new Blocks labels were assigned alphabetically (A-AA), and each EU would be automatically tied in with the rest of the site. Subdatums were established for each block, and consisted generally of two subdatums, the first used from the start of the excavation consisting of the northeast corner stake of the Block, which was generally the highest. This was labeled by block, e.g. subdatum B1 for Block B. The second subdatum was consistently placed at the bottom contact of stratum R4, a prominent B horizon which was present over the entire site. This was due to the thickness of the loess deposit and the difficulty taking vertical provenience when the distance grew to more than 1.5 m. The second datum for each Block would be labeled B2, for instance in Block B. In rare instances, more than two subdatums were needed, but each subdatum would be noted on the field specimen bags and fieldbooks. Each subdatum was measured from the site datum point with a transit (1999-2000) or total station (most subdata for 1999-2000 and all for 2001-2003), thus tying in each individual vertical measurement to the site as a whole.

Excavation Methods

Each excavation block was excavated in a combination natural layers and arbitrary levels (Figure 2.1). Above stratum R4, horizontal provenience for samples was within the 1 m^2 units. Once R4 was reached, excavation was conducted in 0.25 cm^2 quadrants (or quads). Figures 2.2-2.3 show gridding of quads and excavation from the top of stratum R4 in 2001. In general, one or two excavators would work per block, and would excavate one unit to the end of each layer or level. Considering the stratigraphy at the lower locus, and the presence of a thick overburden layer, the typical vertical sequence consisted of the following: overburden; bottom of overburden to R3 surface (Y2), R3 surface to R4 surface (Y3), and R4. When R4 was reached, excavation consisted of 10 cm levels based on the contact of R4 and Y4. This was necessitated because R5 was discontinuous, and the massive silt below R4 (Y4) contained relatively little organic stringers or paleosols that could be followed. Typically eight 10-cm levels would be excavated through Y4 until Sand 2 was reached, e.g., Y4 level 1 (0-10 cm below R4), Y4 level 2 (10-20 cm), Y4 level 3, etc. For the 1999-2000 excavations, excavation was stopped after the paleosol P1 was reached, as this was the lower boundary of the lowest component. A single EU was excavated to bedrock in 1999 in Block E, a total depth of ~4.5 m below the current surface. No archaeological remains were found. In 2001, two EU were taken to bedrock in Block Q. In 2003, a 16 m^2 area was excavated through the lower sands (Unit VI), resulting in an 8 m^2 area excavated to bedrock, but no cultural remains were found. For this excavation into the lower sand, arbitrary 20 cm levels were used, skim shoveling and screening through 1/8" screens. Once the gray sand (Unit V) was reached, this was uncovered in all adjacent units. The gray sand was removed in 20 cm levels. If frozen ground was reached (once in 1999 in Blocks B, C, and G, and once in 2003 in Block Y), excavation would cease until the ground thawed, which usually took one day.

Twenty cm wide baulks were maintained at the edges of most Blocks (10 cm on each side of the control line) (see Figure 2.4). These baulks and the bluff edge were used to maintain vertical control and to assess changes in deposition or stratigraphy during the excavation. The highest point in the unit was designated as the top of the first layer. The baulk would remain until the top of R4 was reached by excavators in adjacent units. Depth measurements on the four corners of each EU were taken at the end of each layer or level. Stratigraphic profiles were then drawn (see below), and the baulks were excavated down to the top of R4. A second series of baulks were used in the same places during the excavation of the lower loess and the archaeological components. These would remain at the top of R4 until the paleosol (P1) was reached and Component 1 was recovered. Then these baulks would be profiled and excavated.

Due to the salvage nature of the excavation, the skim shoveling by 1 m^2 EU and screening method[2] was used for the uppermost disturbed overburden (recent spoil from quarrying activities). Natural sediments below this were troweled by 0.25 m^2 quads in 1999 in order to control the excavation in anticipation of articulated faunal remains, features, and artifacts. All excavated sediments were sieved through 1/4" and 1/8" mesh dry screens. The matrix was generally coarse and dry, so no complications arose with using the dry screening process. All sediments were screened during the 1999-2001 excavations, which covered a contiguous area of 77 m^2. At that point, no cultural materials were discovered above 10 cm below the bottom of R4 except in the disturbed overburden (in other words, the uppermost 1 - 2 m was culturally sterile). From 2000-2003, the sediments between the disturbed surface and R4 were skim shoveled and screened by 1 m^2 units. This provided a 30 cm buffer above cultural materials (Component 3) and necessitated 2 sterile layers before cultural material were recovered (principally in Y4, level 2). Once at the R4 level above the components, sediments were troweled and screened through 1/8" mesh exclusively. The quantity of flakes smaller than 5 mm (1796 lithic specimens, or 18% of total) attests to the quality of the excavators and their diligence and careful work. A new component was discovered in Y3 (above R4) in 2003 in Blocks Y and Z, and once encountered, excavation continued by 0.25 m^2 quad.

Every few days, especially after rain or high wind, the disturbed area around the lower locus was inspected for eroding or disturbed faunal remains and lithic items. All items discovered this way were from disturbed contexts, until in 2001, I discovered faunal remains eroding from the bluff edge below and to the west of the main excavation area. A 1 x 2 m unit was laid out in this area, designated Block W. However, no lithic materials or worked bone was found in association with the faunal remains.

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[2] Skim shoveling involved removing thin (~1-2 cm layers) horizontal layers with a square shovel, in order to identify any relatively large cultural materials at contact.

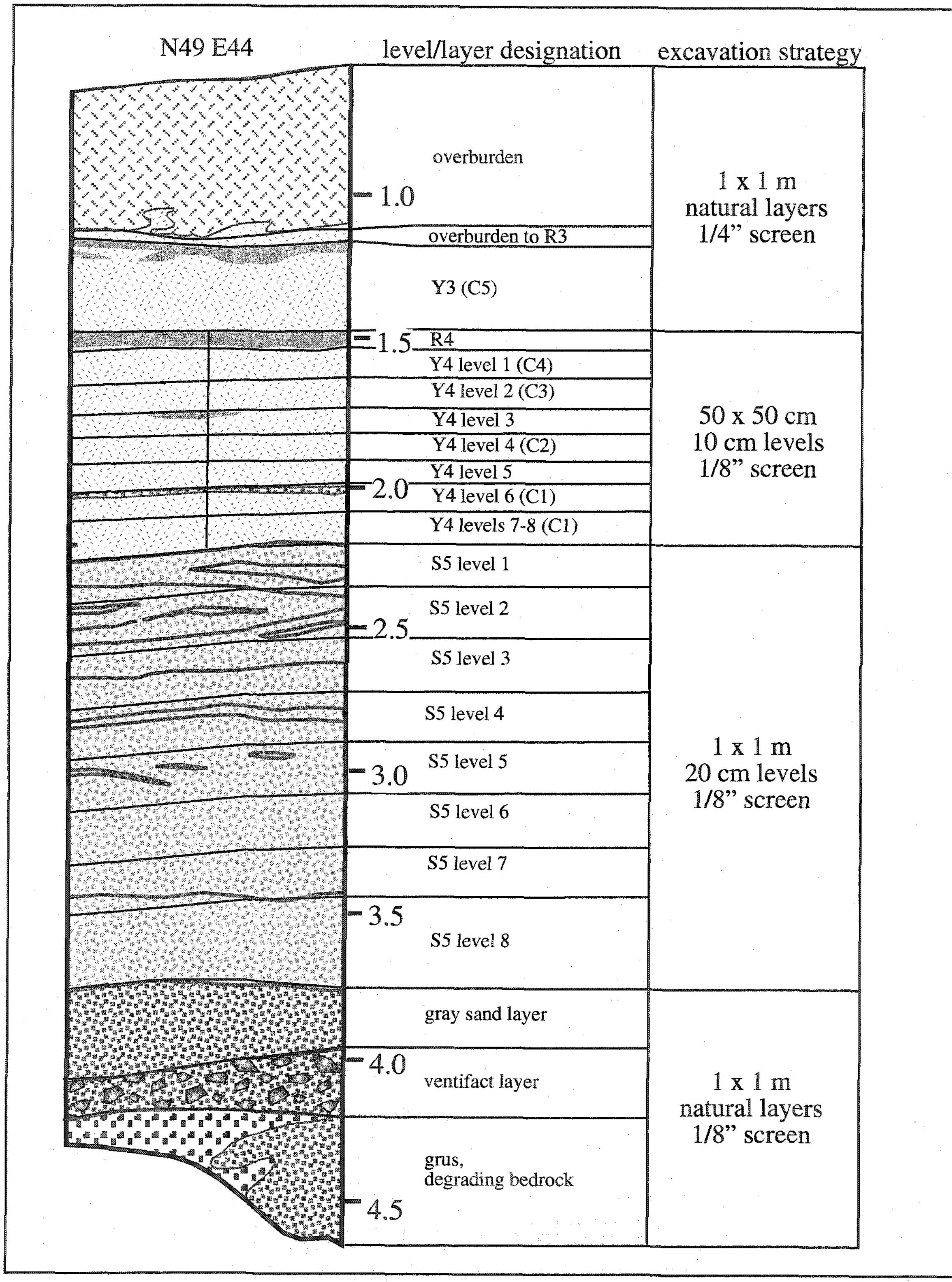

Figure 2.1 Excavation levels and layers superimposed over stratigraphic profile from Block Q, west wall.

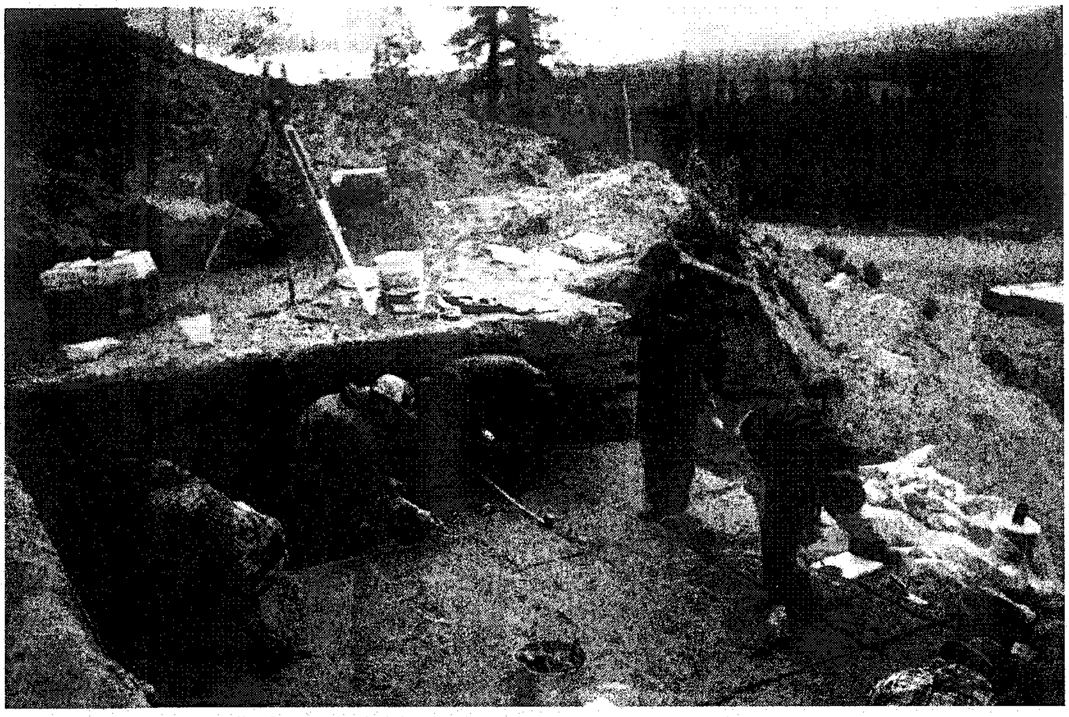

Figure 2.2 Gridding the block excavation at the top of R4, 2001, view south-southeast.

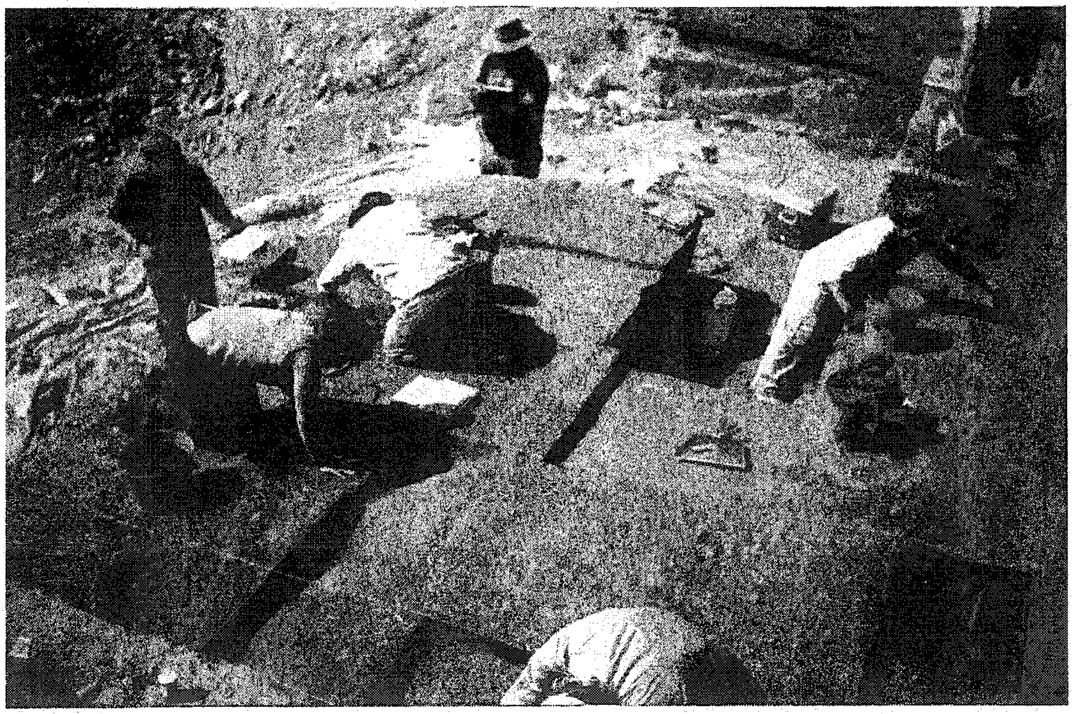

Figure 2.3 Excavation by 50 cm quad at the top of R4, 2001, view southwest.

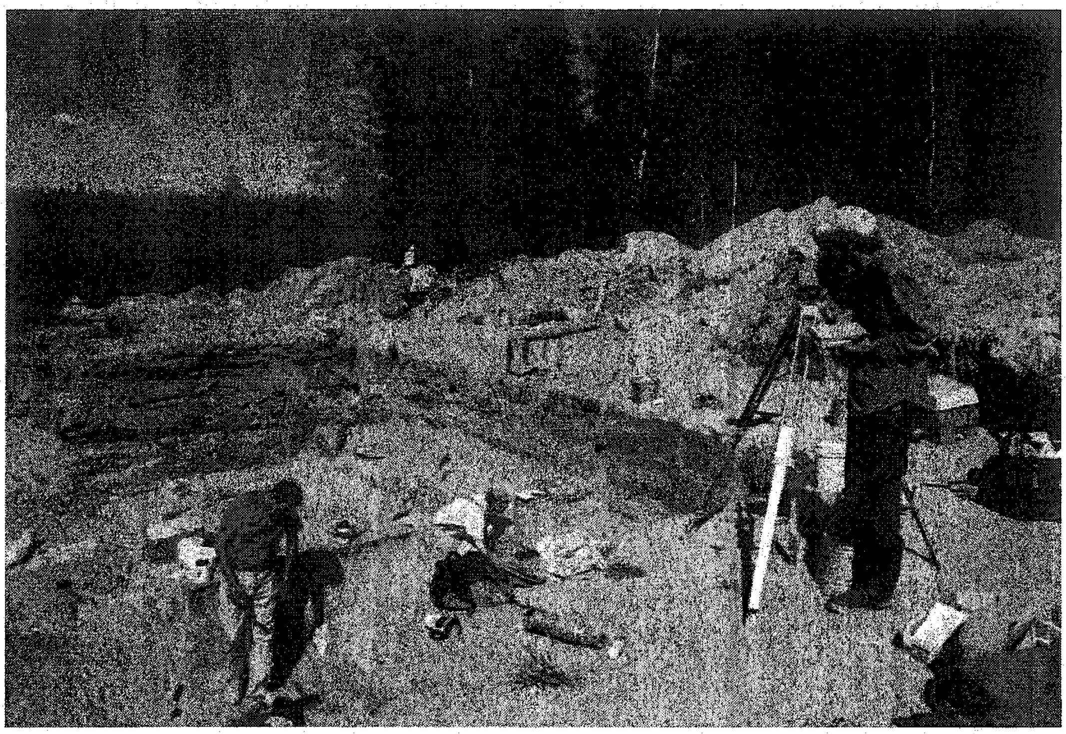

Figure 2.4 Baulk positions during 2001 block excavation, view west-northwest.

Provenience

Three point provenience was used for all cultural material encountered while troweling, including debitage. However, the sediment for each level was screened, and those items were cataloged in one screen bag per level per 0.25 m^2 quad. In practice, excavators removed the sediment in thin layers, so that the excavator could note where the material came from within a few cm within each level. As mentioned above, x-y coordinates were derived from the large nails driven in at the corner of every 1 m^2 EU. Because of the EU orientation, each provenience was tied into the entire site rather than just the EU, e.g. a point of N 33 cm and E 45 cm would be marked as N49.33, E55.45. The elevation coordinate was derived from each subdatum, where a string and line level was used to record depth. Provenience results on the lithic items (by size class) and faunal remains (by weight) recovered from *in situ* components are provided in Tables 2.1 and 2.2.

Table 2.1 Relative frequencies of *in situ* lithic artifacts by provenience precision.

Size Class	*Total N*	*3-pt*	*0.25m²*	*≥1m²*
SC1 (<5 mm)	1,797	36.4	63.2	0.4
SC2 (10-5 mm)	5,657	30.9	67.8	1.3
SC3 (15-10 mm)	1,682	55.5	42.9	1.7
SC4 (20-15 mm)	515	70.3	28.0	1.7
SC5 (25-20 mm)	230	86.1	13.5	0.4
SC6 (30-25 mm)	95	82.1	15.8	2.1
SC7 (35-30 mm)	46	89.1	8.7	2.2
SC8 (40-35 mm)	17	76.5	17.6	5.9
SC9 (>40 mm)	30	96.7	0.0	3.3
TOTAL	10,069	40.3	58.5	1.2

Table 2.2 Relative frequencies of *in situ* faunal weights by provenience precision.

Component	*Total weight (g)*	*3-pt*	*0.25m²*	*≥1m²*
C1	6.17	12.3	48.9	38.7
C2	1.23	97.6	0.0	2.4
C3	11,313.57	97.3	1.5	1.2
C4	82.12	88.6	11.4	0.0
C5[3]	488.59	96.3	2.8	0.8
TOTAL	11,891.68	97.2	1.6	1.2

A fourth point was included for artifacts below R4. Depth below R4 was used to reduce error in depth measurements and to link the vertical distribution of artifacts in all units of the site together during analysis in 1999-2000. Waste flakes found *in situ* and all screened material were recorded by natural level and by 1 meter unit in a field level form. All tools and features were provenienced by metric tape measure from the south and west lines of the excavation block and below subdatum as well as by natural stratigraphic layer. All artifacts were bagged with the following data included: AHRS#, excavation block and unit, natural stratigraphic layer, provenience, date, excavators initials, brief material description, and any pertinent notes.

In 2001-2003, a total station was used to record provenience in addition to the subdatum method, and the sample of >2000 artifact 3-point proveniences with both sub-datum and total station measurements may prove valuable in studying the efficacy of each system. An analysis on 779 3-pointed items (including artifacts and fauna) with both methods showed a mean divergence of 0.00±0.07 m for y measurements (N) and 0.00±0.07 m for x measurements (E) with variances of 0.00 and 0.01 m respectively between the two methods. The vast majority of measurements were within 10 cm of each other (>93%) for x-y. The ~30 points that showed greater than 10 cm

[3] Total faunal weight for Component 5 includes all fauna recovered from stratum Y3.

difference were different in both x and y, suggesting that these differences were the result of cases where multiple items were provenienced at once in one unit. The sequence of recording may have been fouled when one sequence was used for the TS and a different sequence was used when bagging or proveniencing these items with subdatums. Depth measures showed a mean divergence of -0.020 ± 0.024 m between the two methods. This negative skewing is likely due to the weight of the line level and not pulling the string taut. However, the close correspondence between the two methods suggests that the subdatum method, with sufficient training, is adequate to record 3-point measurements; and a total station is not necessary if unavailable.

Feature Excavation Methods

With the exception of natural colluvial feature associated with Component 1 (Feature 6) and a cobble feature in Component 2 (Feature 19), all the remaining features are hearths or firepits, or charcoal scatters associated with the artifacts (Features 1-3, 5, 7-18) in Components 2, 3, and 4. The presence of these features necessitated a different excavation strategy. After Feature 1, each hearth was excavated in a similar fashion. Once the feature was identified, mainly through the rich oxidization of the silt, dense clusters of charcoal, and presence of calcined bone, the feature was excavated to reveal the limits of the oxidization. The feature was then mapped and drawn in a plan view, with multiple depth measurements around its surface. Associated bone fragments, charcoal clusters, and artifacts were drawn. If the 0.25 m^2 quads intersected the feature, then everything around the feature would still be screened within the quad framework, but the area around the hearth would be excavated first in order to document and photograph associated items while the hearth was still on the surface. The hearth was then troweled, and artifacts and bone were three pointed and removed. Larger charcoal clusters were also 3-pointed and bagged separately. The hearth was excavated in a way to generate at least one cross-section (all were lenticular) which was photographed and measured. The excavation continued to the bottom of the hearth (or lowest extent of oxidized silt), and the bottom measurements were taken. In some cases, contour maps were drawn for the hearth bottoms. All of the hearth matrix was collected and bagged (each hearth feature generally filled two to three gallon sized plastic bags). This allowed more detailed analysis in the laboratory and for future work. Feature 1 was excavated in a more detailed manner. All of the above protocols were followed, but in addition, the hearth was divided into 10 x 10 cm units, which were bagged separately. Cross sections were drawn and measured every 10 cm through the hearth.

Faunal Excavation Methods

The presence of fauna at the Gerstle River site is significant, but entailed careful excavation methods for recovery with minimal loss of integrity. Generally, a homogeneous light gray silt lay around the bones in a radius of about 1 cm. Uncovering this gray silt in the matrix of mottled yellow silt acted as an early warning of faunal remains just below the excavation surface. Once a bone was identified, organic probes (pencil shaped twigs) and soft brushes were used to excavate around the bone to decrease the possibility of fragmentation prior to recovery (see Figure 2.6). Larger faunal remains were pedastaled in order to assess the relationships among bone scatters, lithic debris, and features. Once the end of the level was reached, and photographs were taken, the bones were removed and placed (depending on size and condition) in a cradle of folded aluminum foil, with tissue to remove some of the moisture-rich silt. In cases of very delicate fragments, much of the pedastal was removed with the bone at the same time in order for more detailed work to be conducted in the laboratory. The location and shape of faunal remains larger than 2 cm were drawn in the fieldbooks or feature plan map. Smaller faunal remains were drawn when they were part of a feature or were in an area with few faunal remains. This aided in later identification and analysis (Chapter 6)

Stratigraphic Profiles and Sediment Samples

Excavation block walls were photographed and sketched into field notebooks and loose leaf graph paper. After the block was excavated, each wall was cleaned, profiled and photographed. A horizontal string was attached to the block subdatum and the profile was drawn with the aid of a line level. Sediment samples from all depositional units were collected after the 1999 excavation to insure vertical control. These samples were measured from the block subdatum and were labeled with a control number, reducing the possibility of misplacing the sample location. In addition, the sample locations and control number of the sample were sketched on the profile drawing. Characteristics, such as color, texture, consistency, and

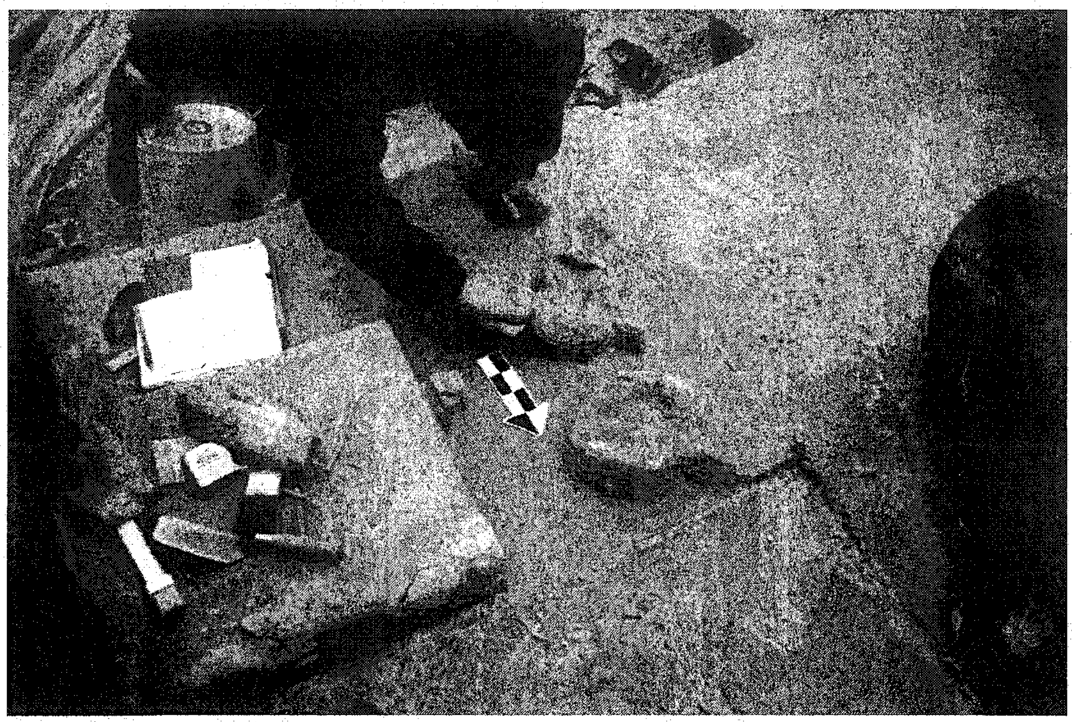

Figure 2.5 Pedastaling bones in Component 3, 2001, view south.

weathering were noted for all stratigraphic horizons. Field names were developed from previous testing conducted by Holmes (1998a) and Potter (2002). A total of 95 linear meters of profiles were drawn at the Gerstle River Lower Locus during these excavations, roughly half were E-W (parallel to the bluff edge) and half were N-S. Most of these profiles extend from the disturbed surface to the lower sand. During 2003, 20 linear meters of profiles were drawn for the 16 m^2 block taken down through the lower sand to bedrock. Sediment samples were retrieved from this area in 2003.

Collection, Curation, and Documentation

All material cultural remains uncovered during the 1999-2003 excavation were collected and are accessioned at the UA Museum under accession numbers UA99-62, UA2000-54, UA2001-71, UA2002-62, UA2003-54. In addition, sediment and geological samples were taken from all stratigraphic units, charcoal samples were taken from all stratigraphic units, and samples of organic remains (wood fragments, etc.) were taken from organic rich layers (like Y3 directly above R4). Artifacts that were eroding out or displaced were also collected and catalogued. In addition, a number of faunal remains and artifacts collected by various researchers since 1996 was acquired from Charles Holmes, and I cataloged, described, and added these to the UA97-061 list (UA97-61-198 through 262).

Each field specimen bag was labeled with site number (XMH-246), block, field specimen number, EU, N and E provenience, depth measurement below datum, below surface, or below R4, excavator's initials, and date. Each bag was given field specimen number, incremental by block. Therefore, each bag had a unique alphanumeric sequence (e.g., B-235, or the 235th bag from Block B). This information was also recorded in each excavator's field book or level form. Once recovered, lithics were bagged by 3-point or screened provenience. No effort was made to wash them, although excess silt was removed with a soft brush in the field. Charcoal samples were placed in aluminum foil pouches and plastic bags. Sediment samples were placed in plastic bags and allowed to dry when back in the laboratory. Faunal remains were treated based on their condition upon excavation. Many smaller fragments would be gently brushed to remove moist silt that could accelerate bone deterioration once in a plastic bag. Larger or more delicate faunal remains were gently brushed to remove the excess silt, wrapped in tissue and placed in aluminum foil which was shaped to match the contours of each bone. While in the field, bones were more carefully brushed to remove the remaining silt and the more fragile specimens were brushed with a dilute mixture of water-soluble glue and water (1:5). These would be checked and stabilized again if necessary in the laboratory. Most specimens did not need this stabilization. A large plastic bag was labeled with the site number and day, and used as a day bag. Bagged specimens for that day were placed into each day bag and housed at the field laboratory.

Each excavator was given either field level forms (1999, 2002) or field books (2000-2001, 2003) to record excavation data. The field level forms were filled out at the completion of each layer or level for each 1m^2 EU. The front of the form contained information on level designation, type of level, stratum/matrix description, beginning and ending measurements for each corner, method of excavation, photographs, excavator, and date. Typical information for each level included estimated grain size (sand or silt), roots, rootlets, size and frequency of any rocks, charcoal fragments, staining, etc. The back of the form contained a catalog for specimens recovered and a graph for drawing finds in that level. The fieldbooks were filled out to record this information. In addition, larger graph paper was used to profile stratigraphy and to map features.

Both color slide and color print film were used to document the site and the excavation process for all years. Important tools, features, *in situ* artifacts and faunal remains, stratigraphic profiles, unit layouts, and excavation overviews were all photo-documented. In the course of these investigations, 43 rolls of film were taken, with 1,300 exposures. Several aerial photographs of the site and surrounding area were taken from a helicopter in the summer of 2001.

Laboratory Methods

Once in from the field, the artifacts were housed in the laboratory, at the UAF Department of Anthropology from 1999-2002, and at Northern Land Use Research, Inc. from 2002-2004. All items were cataloged after each field season. When entering the data into an electronic database and assigning catalog numbers, field books were checked for the accuracy of the specimen bag provenience data. Within screen bags, charcoal, lithic debitage, tools or diagnostic debitage, microblades, faunal remains, and pebbles were separated into different bags and catalogued separately. This was done to facilitate later analyses and to aid curation of fragile items. Details on specific laboratory methods with respect to sediment samples, features, lithics, and faunal remains are outlined in Chapters 4, 5, 6, and 7 respectively. General descriptions are provided below.

Lithic items were examined visually and sediment adhering to the surfaces was gently brushed with a natural-bristle 1/2" brush. None of the lithic tools were washed. Faunal remains were treated based on their condition after unwrapping the specimens. The tissue paper surrounding the bones in the field were removed and discarded and the bones were visually assessed and left on top of their bags to dry further if necessary. When the bones were dry and not fragmenting, no further conservation was done and they were rewrapped in clean tissue and new aluminum foil (if necessary). In some cases, compressed air was used to remove sediment particles from within cancellous bone and within crevices. If the bones were highly friable, then they were brushed with a dilute mixture of water-soluble glue and water (1:5).

CHAPTER 3. SITE SETTING

This chapter describes the environmental and cultural setting of the Gerstle River site. Given the current state of knowledge of early prehistoric sites in interior Alaska, and for readers who are not familiar with the area, it is important to situate the site within both settings. The environmental setting provides a background for the site's geological, sediment, vegetation, and ecological setting and history. Data from recent geological work at the site is integrated with other geological surveys in the area. Ethnographic and ethnogeographic data for the site area are important to understand recent Native use of the area. While this recent use may not be directly linked to the period of site occupation, understanding how people interfaced with the environment near this site can offer information relevant to model prehistoric site use. Given the recent extensive quarrying activities at Gerstle River, it is also important to reconstruct the original site area in order to understand site and landscape use by various occupations at the site. With the destruction of much of the site area, such a reconstruction is also necessary to estimate site boundaries at the Lower Locus.

Environmental Setting

The Gerstle River site is located on a south facing knob of a bedrock hill rising 137 meters above the surrounding outwash plain near the Gerstle River in the middle Tanana basin (Figure 1.1). Vegetation in the surrounding area is typical bottomland spruce forest, though the southern exposures contain some xeric taxa. The access road to the material source and the archaeological site is located near MP 1392 of the Alaska Highway, constructed in 1942 (Holmes and Dilliplane 1976) (see Figure 1.1). Delta Junction is the closest modern town, located 30 miles to the west via the Alaska Highway. The following sections describe the environmental setting of the Gerstle River site and includes summary descriptions of the physiography and climate, surficial and bedrock geology, soils and sediments, and modern flora and fauna.

Physiography and Climate

The Gerstle River is a large braided outwash stream draining a watershed of some 74,000 hectares, with its source at the Gerstle Glacier 37 km to the south in the Alaska Range. The Gerstle River is located approximately 1.1 km west of the archaeological site and flows into the Tanana River approximately 29 km to the north. The site is situated within the Tanana Lowland physiographic region (Warhaftig 1965). This region is essentially a depression between the Alaska Range to the south and the Yukon-Tanana Upland to the North, consisting of the basins of the Tanana and its tributaries, including the Gerstle River (see Magoun and Dean 2000).

Elevation of the Tanana Lowland in this area ranges from 300 to 600 m ASL, trending southeast to northwest. The Alaska Range lies about 30 km to the south, with nearby peaks ranging from 2600 to 3000 m ASL, including Mount Hajdukovich, Mount Silvertip, Black Cap, and Sight Peak. Approximately four km to the south of the site, glaciated highlands (morainal/kame/kettle terrain) are present, representing the limits of various glacial advances, likely Delta 2 and Delta 4 (Hamilton 1973; see below). Permafrost is discontinuous in the study area (Ferrians 1965), but was not encountered at the Lower Locus, largely due to the lack of insulating organic mat and southern exposure. Frozen ground was recorded at several units in the Upper Locus (Holmes 1996 field notes).

Climate in the Tanana Lowland area near Delta Junction is characterized as continental (long cold winters and short warm summers), with average summer temperatures ranging from 46 to 70° F, and average winter temperatures ranging from -11 to 12° F[1]. Average temperatures are 30.1°F for spring, 57.4°F for summer, and 25.2°F for fall, and –1.1°F for winter (WRCC 2003). The Tanana Basin has an average period of 97 frost free days/year (Slaughter and Viereck 1986). Average annual precipitation for the region is very low, at 11.62 inches, with about 30% falling as snow (Magoun and Dean 2000:16). Precipitation averages 1.4 in for spring, 7.0 in for summer, 2.2 in for fall, and 11.6 in for winter. Average snowfall is generally heavier in October and November (9.2 and 8.5 in respectively) and decreases thereafter (see Table 3.1). Average snow depth in the area ranges from 2 in. in October to 10 in. in February, and snow cover generally

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[1] Data used for climate summary derived from weather station data at Delta Junction/Big Delta (FAA/AMOS AP, ALASKA (500770)), located 30 miles to the west-northwest of the Gerstle River site, from 1937 to present (available online through the Western Regional Climate Center at the Desert Research Institute <http://www.wrcc.dri.edu>).

lasts from October to April. Hours of sunlight vary from 21 hours/day in June to four/day in December.

Surface wind patterns vary little at the site; winds generally blow from the east to east-southeast from September to March from 8.6-13.0 mph, and from south to west from April to August from 6.6-9.9 mph (WRCC 2003). The strongest winds are in winter, decreasing in summer, and while relatively high compared with interior Alaska in general, winds are normally lighter at Gerstle River than along the Delta River to the west. The winds generally keep the Lower Locus relatively snow free, except for drifts at the edge of the bluff.

Table 3.1 Regional climate summary[2] (data from NCDC/WRCC 2003).

Month	*Avg. Temperature (°F)*	*Mean Total Water Equivalent Precipitation (in.)*	*Mean Snowfall (in.)*	*Mean Snow depth (in.)*	*Prevailing Wind*	*Avg. Wind Speed (mph)*
January	-2.6	0.33	5.6	8	ESE	13.0
February	2.3	0.32	5.2	10	ESE	11.8
March	14.2	0.25	4.3	9	E	10.6
April	32.1	0.25	2.8	4	S	9.9
May	47.8	0.86	0.6	0	W	8.7
June	57.5	2.27	0.0	0	W	7.8
July	60.8	2.66	0.0	0	W	6.6
August	55.5	2.01	0.0	0	W	6.8
September	44.4	1.09	1.6	2	E	8.5
October	24.1	0.63	9.2	5	E	8.8
November	6.4	0.47	8.5	6	ESE	12.8
December	0.1	0.36	5.8	4	ESE	11.0
Annual average	28.6	0.96	3.6	4	ESE	9.7

Geology

Moffit described and mapped the geology in the area between the Delta River and the Canadian border in a USGS survey bulletin (USGS 1954), however, there is a general lack of exposures necessary for detailing bedrock geology in the Gerstle River area. Data from the resulting geologic map (at a scale of 1:250,000) is illustrated in Figure 3.1. The Gerstle River site lies within an area of unconsolidated quaternary deposits, largely the result of stream and lake alluvial deposits and outwash gravel. Glacial moraines are present about 4 km south of the site

[2] Climate data are derived from 1937-2001 records for precipitation, snowfall, and snow depth, 1971-2000 for temperature, 1992-2002 for wind direction, and 1996-2002 for wind speed (NCDC/WRCC 2003).

(see below). Bedrock in the Alaska Range directly south of the site include Pre-Cambrian schists and intrusive late Mesozoic granites (primarily diorites) (USGS 1954). Gerstle hill is likely related to these granitic intrusives (see below). No obsidian or rhyolitic outcrops are known in the area, but I observed coarse-grained chert nodules in the Gerstle River outwash plain.

The surficial and bedrock geology has been previously described for the Gerstle River site area in the form of three ADOT&PF-funded geotechnical studies relating to rip-rap quarrying activities (Balvin 1962; Brazo 1977; Solie 1999) and various DMTC geotechnical studies relating to a training mine below the site have produced pertinent data (Whit Hicks, DMTC Director, 2001, personal communication). Balvin (1962) conducted a brief geotechnical study of the area (no subsurface testing was involved) as an assessment of the existing material site. Balvin (1962:1) described the exposed bedrock face below the Lower Locus as:

> medium-grained granite containing sparsely scattered inclusions of quartz diorite to ten inches in diameter… [and w]eathering of the bedrock surface immediately below the silt has rounded the joint blocks to depths of six to eight feet.

This is consistent with the appearance of the bedrock in the present. Balvin notes that "drilling and blasting will be required for excavation" and "[t]he quantity of material is unlimited" (Balvin 1962: 2). Brazo (1977) described the bedrock below the Lower Locus at Quarry A as "fractured Cretaceous granite" (1977: 2).

Balvin (1962) notes that the Gerstle River material site (MS 623-075-2) bedrock is a fractured Cretaceous granite, producing good rip-rap, and importantly that "some artifacts of historic value have been recovered from this location." To date, no archaeological information is available for the period before Holmes identified the site in 1976 (Holmes and Dilliplane 1976).

ADOT&PF geologist Diana Solie compiled the results of five 1994 and thirteen 1999 core holes and four 1994 grab samples at and around the Gerstle River site. The bedrock was described as "equigranular medium-grained gray biotite granite" (Solie 1999: 2). The work pad was unvegetated (from at least the late 1970s), consisting of broken bedrock fragments ranging in size from boulder to granules. The water table was encountered at one core (99-13), located near the center of the quarry at a depth of 4.5 m below surface (Solie 1999:3). Of the thirteen cores, eight are used here to form a transect from the hillside above the Upper Locus to the Southern Hilltop. Data from these cores are summarized in Table 3.2 and illustrated in Figure 3.2. Locations of these cores in Figure 3.2 was derived from Solie's report (1999), and the locations are approximate. The core samples generally reflect sediment depth observed in archaeological test pits in the Upper and Lower Loci areas. The deepest sediment accumulation occurs at the Lower Locus area (Core 94-3). This core was actually located within Block U, EUN50E47 as a 10 cm diameter rock and sand-filled hole extending through the sediments. From these data, it is clear that there was considerable sediment (~ 2 m) present on the hill at the Lower Locus prior to its destruction. Core 94-1, on the crest of the hill's southern edge, had exposed bedrock in 1994.

Table 3.2 ADOT&PF geotechnical core data (1995, 1999) (derived in part from Solie 1999).

Core	*Location*	*Elevation (m ASL)*	*Distance to next core*	*Surface sediments (sediments overlying bedrock)*
99-3	Upslope from 99-5 and Upper Locus	465	N/A	0.00-0.15 m, organic mat 0.15-1.20 m, brown silt, dry with angular rock fragments 1.20-2.60 m, gray rock, broken (Biotite Granite) 2.60+ m, gray rock, hard (Biotite Granite)
99-5	Upslope from Upper Locus	449	60 m SSE	0.00-0.10 m, organic mat 0.10-1.50 m, brown silt, dry 1.50+ m, gray rock, hard (Biotite Granite)
99-7	Hilltop north of Upper Locus (near Block H)	441	38 m SE	0.00-0.10 m, organic silt 0.10-1.80 m, brown silt, dry (frozen at 1.00 m) 1.80-3.00 m, brown silt with abundant angular rock fragments 3.00+ m, rock, very soft (Biotite Granite)
99-2	Midway downslope between 99-7 and 99-1	432	30 m SSW	0.00-0.05 m, organic mat 0.05-0.60 m, organic silt, dry 0.60-1.20 m, brown silt with angular rock fragments 1.20+ m, brown rock, mod. Hard (Monzonite)
99-1	At Upper Locus	428	30 m SSW	0.00-0.15 m, organic mat 0.15-2.10 m, yellow/brown silt with angular rock fragments 2.10+ m, gray rock, hard (Biotite Granite)
94-2	On edge of bluff below Upper Locus	425	28 m S	0.00-3.80 m, brown silt, dry – slightly moist 3.80+ m, brown/orange rock, soft (Granite)
94-3	At Lower Locus, Block U	417	75 m W	0.00-5.50 m, brown silt, dry – slightly moist 5.50+ m, rock, soft (Granite)
94-4	On slope of Southern Hill	416	50 m SW	0.00-1.80 m, brown silt 1.80+ m, gray rock, hard (Granite)

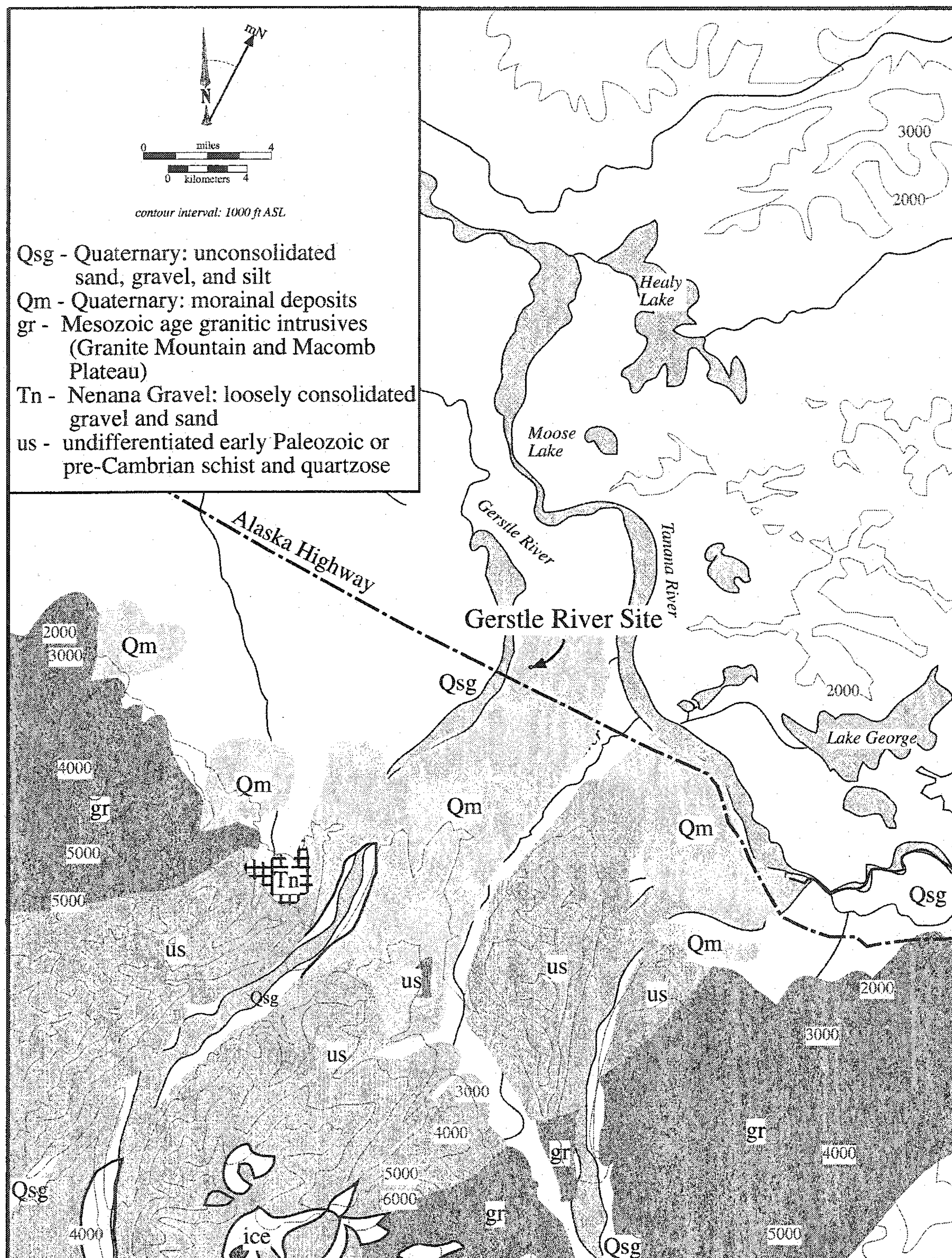

Figure 3.1 Bedrock Geology near the Gerstle River site (data from USGS 1954) .

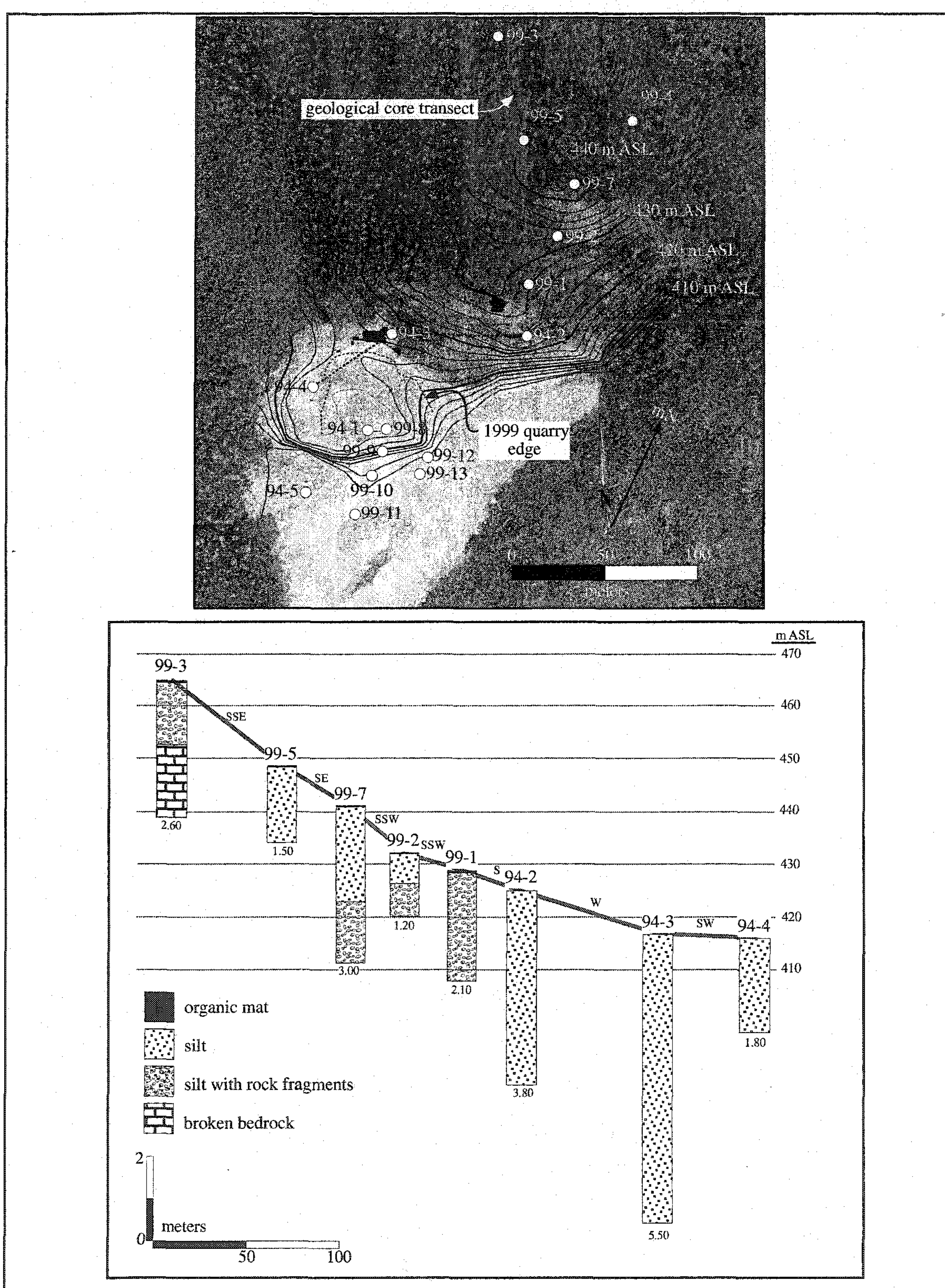

Figure 3.2 Geological Testing at Gerstle River, 1998 (data derived in part from Solie 1999)

Glacial Geology

Glacial terrain features in the Gerstle River area have been previously described (Hamilton 1973: 17-24; see also Pewe and Holmes 1964; Holmes 1965), and this summary generally follows Hamilton (1973). The limits of glacial and stadial advances are illustrated in Figure 3.3. Pleistocene glaciers were largely constrained to montane valleys on the north side of the Alaska Range, with terminal expansions onto the Tanana Lowland (Pewe and Reger 1983: 47). Glacier ice flowed down the Gerstle River valley, and a westward extension of the Johnson valley glacier extended into the Little Gerstle River valley. The outermost moraine belt is comparable to the Delta glaciation in the neighboring Delta valley, and is characterized by gentle slopes, rounded kames, and thaw lakes with considerable filling (Hamilton 1973: 17). The Delta glaciation terminal moraine lies 3 km south of the Gerstle River site and can be readily seen from the site surface. The Donnelly glaciation terminal moraine lies 4 km south of the Gerstle River site and is characterized as "relatively unmodified" (Hamilton 1973: 19). Aside from evidence of these two major glaciations, one major undated stadial readvance is apparent in the Gerstle River valley, extending to nearly the furthest Donnelly extent.

Glacial radiocarbon chronology for the Donnelly glaciation is not well defined. A date of 25300±950 BP from an exposure along the Gerstle River provides a maximum limiting date for the Donnelly glaciation (Hamilton 1973: 33). Later stadial readvances, termed Donnelly II and Donnelly III date to between 14800±650 BP - 9830±320 BP after 9830±320 BP respectively (Hamilton 1973: 34). The Donnelly I-II sequence was observed in the Gerstle River valley, with Donnelly III apparently absent, though all three ice advances were observed in the Little Gerstle River valley (35) (see Figure 3.3). In his discussion of the Shaw Creek area quaternary geology, Dilley (1998:249-252) uses the relatively well-dated Nenana River glacial sequence as a proxy for the Donnelly sequence (TenBrink and Waythomas 1985). However, an exact correlation between the various glacial and stadial advances in the Gerstle/Delta and Nenana areas has not been established to date. Table 3.3 lists the Nenana River sequence with possible correlates from the Delta/Gerstle area.

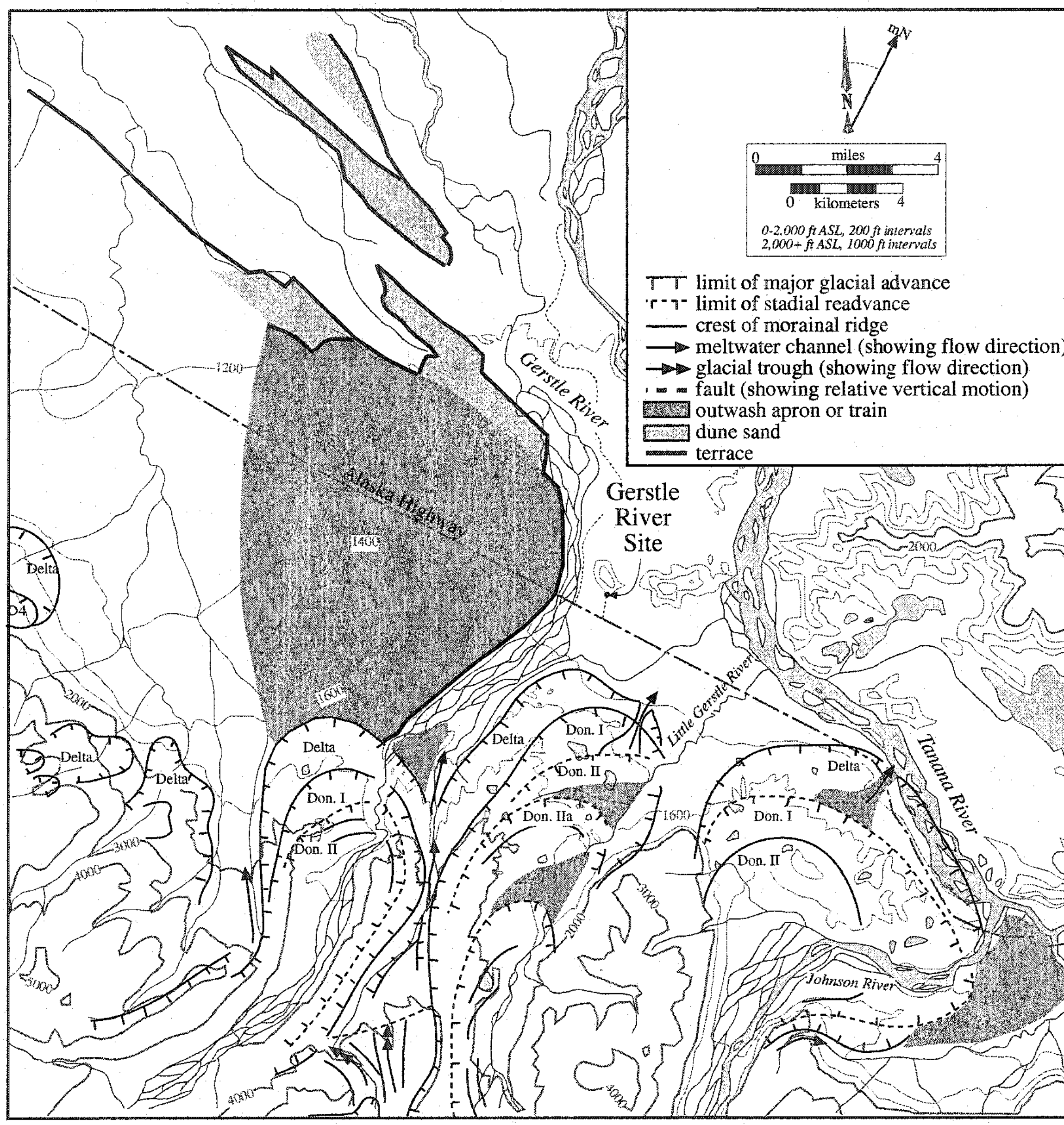

Figure 3.3 Glacial terrain in the Gerstle River area (data from Hamilton 1976).

Table 3.3 Comparison of Nenana River and Delta/Gerstle glacial sequence (derived from TenBrink and Waythomas 1985; Dilley 1998; Hamilton 1973).

Nenana River Sequence	*Delta/Gerstle Sequence (limiting dates)*
Riley Creek I (25000-17000 BP)	Donnelly I (25300±950 BP – 14800±650 BP)
Riley Creek II (15000-13500 BP)	Donnelly II and IIa (14800±650 BP – 9830±320 BP)
Riley Creek III (12800-11800 BP)	
Riley Creek IV (10500-9500 BP)	Donnelly III (9830±320 BP – 5900±250 BP)

Soils, Sediments, and Vegetation

Detailed information on soils and sediments in the Gerstle River site is available in a Natural Resources Conservation Service, U.S. Dept. of Agriculture publication (Swanson 2002). There are several soil complexes near the Gerstle River site, including well-drained and poorly drained floodplain silt loams, one silt loam found on north-facing slopes, and two typic eutrocryepts, on south-facing slopes (see Figure 3.4). A more detailed discussion of site-specific stratigraphy and sediments is provided in Chapter 4.

The sediments at the Gerstle River site, Upper and Lower Loci are characterized as *Typic Eutrocryepts, bedrock substratum, 30-60° slopes*, and are typically found on shoulders and south-facing slopes of bedrock uplands (Swanson 2002: 40-41). Drainage is considered well to excessively drained, with a depth averaging 25-114 cm to the mineral soil surface (typically weathered bedrock). No flooding events are evident, and the hazards of colluvial and aeolian erosion are considered to be none to moderate if the organic mat is present, and severe if the mat is removed (Swanson 2002: 41). Permeability is rapid in the organic mat, moderate in medium-textured layers (silt loam), and moderate to rapid in coarse-textured sediments (sand, grus, weathered bedrock) (2002: 41).

Vegetation in the area is characterized as bottomland boreal forest. Major forest types associated with this soil complex are white spruce and white spruce-quaking aspen. Dominant tree species are white spruce, quaking aspen, with smaller numbers of paper birch and balsam poplar. Trees evident in the Gerstle River Upper Locus and Lower Locus (prior to disturbance) were almost exclusively white spruce, with about 8 inches diameter on 6-8 ft centers (from sketch in Balvin 1962). Currently, the Lower Locus has vegetation resulting from recent removal of the trees, understory, and organic mat, and includes birch near the backslope to the north.

Major understory species present at the site include prickly rose, reedgrass, horsetail, highbush cranberry, various grasses, American twinflower, and feathermoss, though much of the

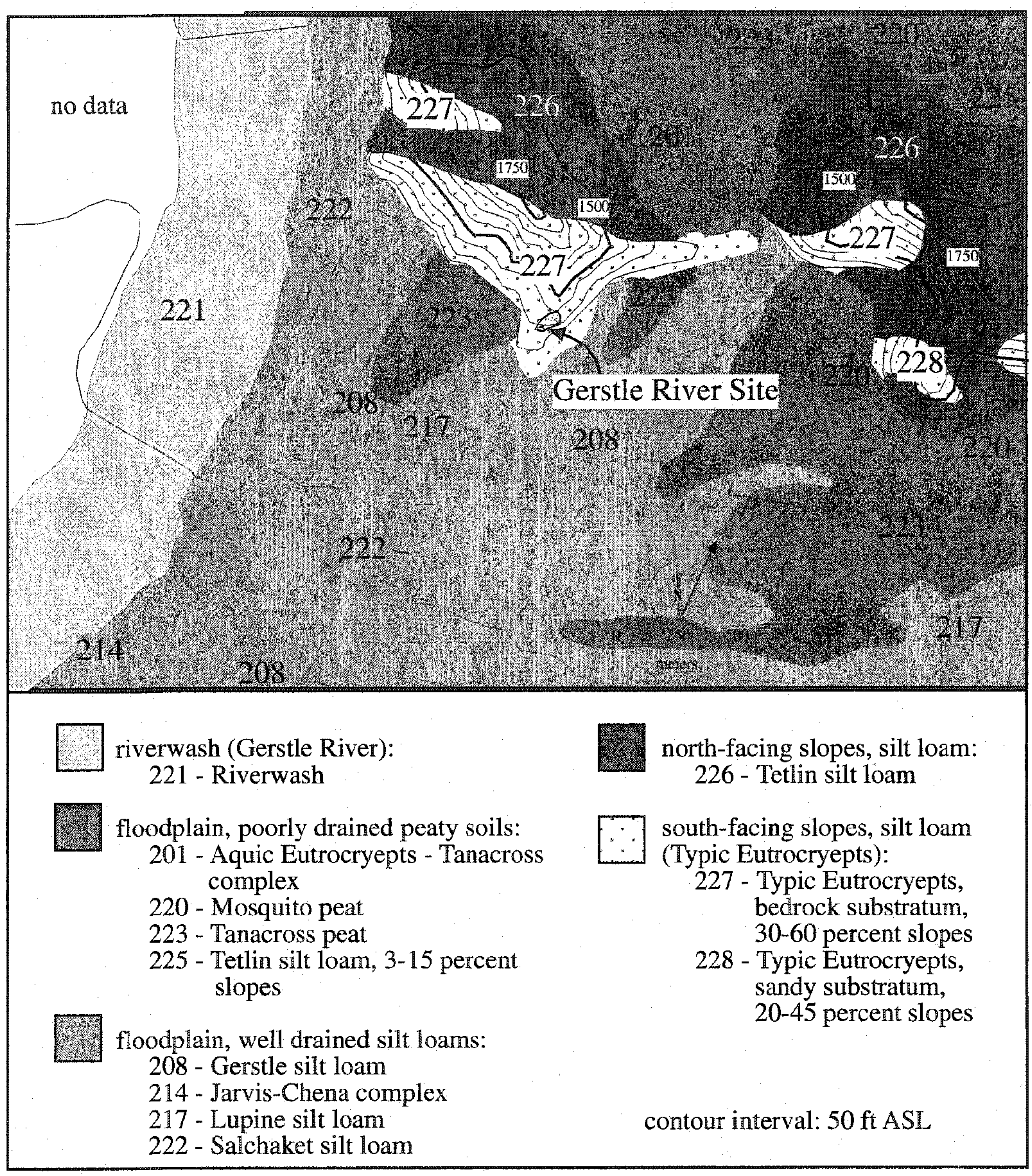

Figure 3.4 Soils and vegetation distribution in the Gerstle River area (data from Swanson 2002).

Lower Locus has been devegetated due to human disturbance. Reedgrass is the most common vegetation in the recently disturbed areas. In addition, grass was seeded on the hillslope directly east of the Lower Locus by DMTC in order to stabilize the slope. The Upper Locus and steep slope below it have xeric floral taxa, including grasses and sagewort (*Artemisia frigida*).

North-facing slopes in the immediate site area are characterized as *Tetlin silt loam*, found on side slopes of bedrock hills. Drainage is considered poor, with about 25-102 cm depth to permafrost (Swanson 2002: 39-40). Typical associated vegetation near the site consists of white and black spruce, prickly rose, reedgrass, polargrass, horsetail, lingonberry, bunchberry dogwood, wintergreen, American twinflower, and sphagnum and feathermoss understory (Swanson 2002: 40).

The Gerstle River floodplain is overlain by several types of alluvial sediments, including well drained *Lupine*, *Gerstle*, and *Salchaket silt loams* to the south of the Gerstle River site, and *Tanacross peat*, a poorly drained peaty soil present to low-lying areas to the east and west of the site (Figure 3.4) (Swanson 2002: 25, 33, 36, 38). The silt loams are characterized as having a slope of 0-3 percent, depth of sediment from 20-152 cm to mineral soil. Native vegetation is similar for the well-drained areas, with Gerstle and Salchaket silt loams consisting of white spruce, white spruce-balsam poplar, and white spruce-quaking aspen forest types, with understories of Labrador tea ledum, lingonberry, bog blueberry, black spruce, black crowberry, prickly rose, horsetail, and bunchberry dogwoods (Swanson 2002). Vegetation associated with Lupine silt loam consists of black spruce forest type, with sphagnum moss understory. The *Tanacross peat* sediment averages 13-64 cm depth to permafrost, and native vegetation consists of the black spruce forest type, with Labrador tea ledum, diamondleaf willow, bog blueberry, polargrass, and sphagnum moss understory (Swanson 2002: 38).

Primary succession on the Tanana floodplain has been described in Viereck et al. (1992) and summarized in Magoun and Dean (2000:19-27) in twelve stages, with early succession of open shrubland, consisting of willows, herbs, alder, with middle stage forests of mixed poplar/white spruce, and later dominance of white spruce. Later stages, including transition to black spruce bogs, are less well defined (Magoun and Dean 2000:19; Mann, et al. 1995). Local fires are the primary disturbance factor in the Tanana region, and Mann, et al. 1995) suggest that white spruce forests on surfaces older than 400 years "are probably post-fire, secondary successional stands" (Magoun and Dean 2000:28).

The area to the southwest and southeast of the site have been cleared of trees at some point in the past, perhaps in preparation for agricultural activities, but were never used for this purpose, and have overgrown with colonizing species like willow and grasses. Black spruce and sphagnum moss are the dominant vegetation in areas of little disturbance.

Modern Fauna

Typical modern fauna in the middle Tanana area has been summarized in a number of recent environmental or agency reports (Anderson et al. 2000; Burgess et al. 2000; Burgess and Lawhead 2000; Magoun and Dean 2000). Specific wildlife surveys near Gerstle River have not been conducted, though ongoing surveys related to Fort Greely (recently renamed Donnelly Training Area) have been undertaken (CEMML 2003). The summary below is derived primarily from species lists in Magoun and Dean (2000) and Anderson et al. (2000).

Mammals in the Gerstle River area include moose (*Alces alces*), reintroduced plains bison (*Bison bison bison*), grizzly bear (*Ursus arctos*) and black bear (*Ursus americanus*), caribou (*Rangifer tarandus*), red fox (*Vulpes vulpes*), snowshoe hare (*Lepus americanus*), lynx, wolf (*Canus lupus*), wolverine (*Gulo gulo*), beaver (*Castor canadensis*), porcupine (*Erethizon dorsatum*), pine marten (*Martes americana*), mink, weasels (*Musetela* spp.), muskrat (*Ondatra zibethicus*), river otter (*Lutra canadensis*), and red squirrel (*Tamiasciurus hudsonicus*). Small mammals include various species of vole, lemmings, shrews, mice, and bat. Dall sheep (*Ovis dalli*) inhabit higher ground in the Alaska Range south of the site.

Magoun and Dean (2000:46-55) summarize the rich diversity of birds in the Tanana floodplain. Waterfowl typically do no utilize upland white spruce forest areas (such as that at the Gerstle River site hill), but are numerous on low-lying Tanana floodplain (Magoun and Dean 2000:48). Waterfowl include numerous species of ducks and geese, trumpeter swans, and sandhill cranes. Upland game species include ptarmigan and grouse. Passerines include various woodpeckers, thrushes, sparrows, and warblers. Raptors include peregrine falcons, golden eagles, bald eagles, red-tailed hawks, and various owl species.

Although salmon do not now penetrate past the Goodpaster River along the Tanana River, a number of freshwater fish are present in the Gerstle River area. Fish in the Tanana River include burbot, grayling, sheefish, whitefish, and suckers. Gerstle River, as a glacially fed stream, does not contain large quantities of fish, but clear water creeks and lakes to the north contain a number of species, such as whitefish, burbot, and suckerfish.

The distribution and array of various resources near the Gerstle River site are illustrated in Figure 3.5, based on Alaska Department of Fish and Game habitat atlas (ADF&G 1973). In addition to the species listed in Figure 3.5, wolverines, wolves, moose, and brown and black bear are ubiquitous. Within 5 km of Gerstle River, modern potential resources include waterfowl nesting and molting areas and bison summer range and calving areas (of transplanted plains bison). Within 10 km, potential resources include moose fall and winter concentration areas and modern caribou territory to the south. Within 20 km, modern potential resources include extensive waterfowl nesting areas, several moose fall/winter concentrations, and Dall sheep habitat in the foothills of the Alaska Range. The plains bison herd in Delta ranges as far as the Gerstle River area in recent years. Details on this herd and its history can be found in Dubois and Rogers (2000). Mammalian visitors to the site or near vicinity during the five years of excavation included numerous moose, grizzly bears, porcupines, and squirrels.

The nearest caribou herd to the site is the Delta caribou herd located in the Tanana basin. Estimates on herd size are 2,800 animals in 1973, from 4,000 to 10,700 in 1979-1989, and a decreasing trend is evident from 8,000 in 1990 to a 1999 estimate of 2,950 animals (Valkenburg et al. 2002:tables 17a and 17b).

Paleoenvironmental Setting

Late Pleistocene and Early Holocene paleoenvironments in the Tanana basin have been the focus of several studies in recent years (Bigelow 1997; Dilley 1998; Bigelow and Powers 2001) as well as for earlier syntheses of general Beringian paleoecology and geology (Hopkins, et al. 1982; Guthrie 1990; Ager 1975, 1983).

Ager and Brubaker (1985) delineate five broad pollen zones for the Tanana basin during the terminal Pleistocene and Holocene periods. The *Herb Zone* (Late Glacial Maximum - 14000 BP) represents steppe tundra vegetation during glacial conditions, predominately grasses, sedges, and forbs. The *Betula Zone* (14000-11500 BP) represents shrub tundra, with shrub birch as the predominant taxon, and a corresponding decrease in herb taxa. The *Populus-Salix Zone* (11500-9500 BP) represents a decrease in birch and increase in poplar and willow (probably *Populus balsamifera*). The Picea-Betula Zone (9500-8400 BP) represents the arrival of spruce in the

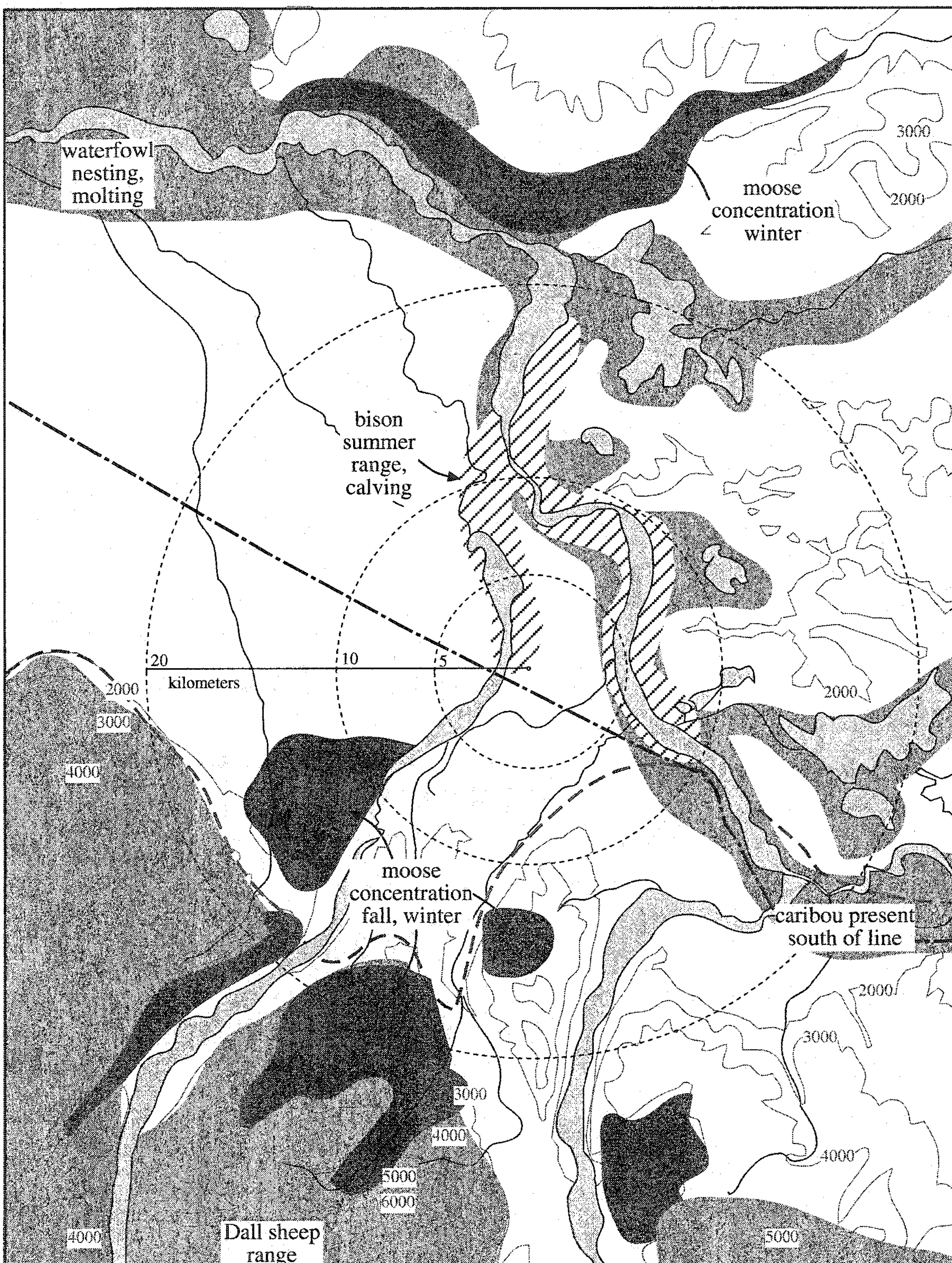

Figure 3.5 Modern large mammal resources near Gerstle River (data from ADF&G 1973).

Tanana basin, from west (downstream) to east (upstream), along with decrease in birch. The Picea-Betula-Alnus Zone (8400 BP - recent) represents a boreal forest similar in most respects to the present vegetation through large portions of interior Alaska, though a decline in spruce is noted around 6500 BP (Ager 1983).

A number of pollen analyses were conducted on cores from Birch Lake, located approximately 103 km (65 miles) northwest of Gerstle River, north of the Tanana River (Ager 1975; 1983; Bigelow 1997; Bigelow and Powers 2001). Radiocarbon dating controls are present at 4810±60 BP, 6590±60 BP, 6630±60 BP, 8480±60 BP, 9210±340 BP, 11420±120 BP, 11840±100 BP, and 12780±60 BP, thus providing a secure record for the time period the faunal remains at Gerstle River. Bigelow's (1997) work at Birch Lake in general reinforces Ager and Brubaker's (1985) sequence. Bigelow defined five pollen zones: BL-1 (12500-12200 BP) corresponding to the Herb Zone, BL-2 (12200-9300 BP) corresponding to the Birch Zone, BL-3 (9300-8100 BP) corresponding to the Poplar-Willow Zone, BL-4 (8100-6900 BP) corresponding to the Picea-Betula-Alnus zone, and BL-5a (6900 BP to present, with an increase in spruce and decrease in birch after 5300 BP). Healy Lake and George Lake, about 15 km E and NNE respectively were also cored for pollen analysis (Ager 1975). The former contained only pollen zone 3B (8400 BP – present), and the latter had a number of radiocarbon reversals (Ager 1975:77), however the pollen zones could be linked with those from Birch Lake. The pollen data was generally similar between the lakes.

While these data are coarse-grained, they can provide a general setting within which to examine the site components. The Birch Lake core data (Bigelow 1997:119-120, Figures 4.7-4.9) forms a basis for comparison with components recovered at Gerstle River. Realizing that the resolution differences between these data are not fine-grained (i.e., age model used for the pollen data calibration vs. radiocarbon dates of short-term occupations), useful observations can be made. Components 1 and 2 occur during the Birch Zone (BL-2). Vegetation was likely similar during the period of these occupations (i.e., dominance of birch and sedges, based on the Birch Lake core data from 10000 to 8500 BP. The Component 1 occupation occurred during a period of increased sedge frequencies. Components 3, 4, and 5 occur during the Poplar-Willow Zone (BL-3), when the overall dominance of birch and willow continued, but poplar increased in the Tanana Lowlands (Bigelow 1997:118). Component 6 (present at the Upper Locus) occurs during BL-4, after colonization of spruce and during a decline in sedges. Component 7 (present at the Upper Locus) occurs during BL-5b, characterized by increasing spruce and decreasing birch

(Bigelow 1997:119-120). The similarities in Components 2 through 5 and the differences in Components 6 and 7 are interesting in that the former occur during a period exhibiting relatively similar vegetation patterns, very different from the latter, where the environment was dominated by spruce forest (see Chapter 4).

A more fine-grained analysis of several interior Alaskan lake pollen records was presented by Bigelow and Powers (2001). From about 14000-13000 cal BP, they document significant increases of birch, with elements of grasses, sedges, and forbs present, and a generally warmer environment. From 13000-11000 cal BP, central Alaska was characterized as a birch shrub tundra. At Birch Lake, artemisia increased due to increasing aridity. The Younger Dryas occurred from 13000-11300 cal BP, marking a worldwide climatic deterioration (Peteet 1995). At around 11000 cal BP, approximately the period of occupations at Gerstle River Components 1 and 2, birch still dominated, with generally equal amounts of willow, grasses, and sedges. Between 11000-9500 cal BP, poplar and later spruce expand, though by 10000±250 cal BP, the period of Gerstle River Component 3, spruce had not yet invaded to Birch Lake, though it was present at Harding Lake (Bigelow and Powers 2001:figure 8).

Recent work has narrowed the timing of the Holocene thermal maximum for the upper Tanana basin to initiation between 12000 and 11000 cal BP and termination between 10000 and 9000 cal BP (Kaufman et al. 2004). Summer insolation reached its maximum values around 10000 cal BP, and Mason et al (2001) argue that the increased temperatures and reduced moisture may have led to a presumed dearth in dated components in this period, however the presence of Gerstle River occupations in this time period suggests that this apparent lack may be due to the small sample size (see discussion in Chapter 11).

Cultural Setting

Archaeology of Interior Alaska

This section summarizes current interpretations of Interior Alaskan archaeology, with an emphasis on the Tanana basin (including the Nenana River basin and Tangle Lakes). It is beyond the scope of this study to detail the history of archaeological thought with respect to Interior Alaska, but I will discuss pertinent hypotheses and influential sites that have guided perspectives on Interior Alaskan archaeology. Interior Alaska, for the purposes of this overview, is defined as the Yukon watershed upstream from the confluence of the Koyukuk and Yukon rivers, the Susitna-Matanuska River watershed, and the Copper River watersheds.

Several themes are explored that impact how Alaskan archaeologists have interpreted the material record in this region. These themes range from empirical limitations of the record to theoretical expectations derived from overly simplified (often implicit) typologies, but are interconnected at the level of integration of site specific and theoretical interpretations. First, there are very few large block excavations in this region. Second, the archaeological investigations in this region are typically limited by lack of explicit typologies for many tool types. Third, cultural frameworks from which to derive interpretations about land use and subsistence use patterns have problems relating to the relative absence of supporting taxonomic, lithic technological, use-wear, and related studies. Fourth, our understanding of site structure and organization within this region is rudimentary. Much of these problems are a direct result of the relative lack of intensive large scale excavations and peripheral analyses, however, some of these limitations are based out of insufficiently linking pertinent research problems with excavation methodologies.

For the purposes of assessing the place of Gerstle River assemblages within the cultural frameworks that have been established, a brief review of some of the more influential technological groupings for the period between 12000 and 6000 BP is apropos. Only three groupings have gained widespread recognition if not complete acceptance for Interior Alaska: *Denali Complex*, *Nenana Complex*, and *(Northern) Paleoindian Tradition.* Other groupings have been proposed, such as Chindadn Complex (Cook 1969; Dixon 1985), Beringian (West 1996), and East Beringian (Holmes 2001), but these have not gained widespread support. It is important to note that the definitions of these complexes have been derived primarily on the presence/absence of microblade technology and small triangular bifaces classified as "chindadn points," though there are apparently multiple types that have been thus termed (see Holmes 2001).

The Nenana Complex, first proposed by Powers and Hoffecker (1989), incorporated only four components from the Nenana Basin: Dry Creek C1, Walker Road C1, Moose Creek C1, and Owl Ridge C1 (see also Hoffecker et al. 1993; Goebel 1990; Pearson 1999a). Other researchers have assigned other components to this complex, generally on the basis of absence of microblade technology, e.g. Broken Mammoth CZ 4, Swan Point CZ 3 (Yesner et al. 1992; Dixon 2001;

Yesner and Pearson 2002), or on the basis of small triangular bifaces termed Chindadn points, e.g. Healy Lake Village Chindadn, and Chugwater (Lively 1996:311). The Nenana Complex was defined by an "absence of microblade technology," rarity of burins, and presence of end scrapers, and small triangular/lanceolate bifaces (Powers and Hoffecker 1989:278).

The distribution of microblade technology is discussed below. Chindadn points have been found in association with microblade technology at Healy Lake Chindadn (Cook 1969, 1996), and while some have argued that these sites are mixed, the linkage between microblades and chindadn points cannot be fully evaluated given present information. A formal, explicit typology of bifaces within Nenana, Denali, and Northern Paleoindian has not been attempted. The most explicit examination of bifacial forms in Nenana and Denali components was conducted by Holmes (2001:162-165), who differentiates four types of bifaces, termed Chindadn Types 1-4. Type 1 represents the round-based forms typical of some Nenana assemblages (and Chugwater), while Type 2 represents more amorphous or square-based forms typical of some Tanana assemblages (and Dry Creek C1). Type 3 represents concave-based, basally thinned forms found at Healy Lake, Jay Creek Ridge, Swan Point CZ 3, and Erodaway (Holmes 2001). Type 4 represents concave based, edge ground lanceolate forms present at Healy Lake Village, Dry Creek C2, and Swan Point CZ 3, all in association with microblades (Holmes 2001:165). Clearly, cultural complex definitions based on a certain artifact type without detailed typological analyses of the artifact class within which they belong (projectile point class) or technological organization studies can be problematic.

The other two defining characteristics of Nenana are the rarity of burins and presence of end scrapers (see above). Burins are typically part of microblade technology, and a comparison of burin and microblade co-occurrence at Dry Creek C2 (13 clusters), shows that the two are highly correlated (Hoffecker 1983a, b). The absence of microblades and burins should be seen as part of a similar co-occurring set of artifact types, which may represent a specific "toolkit," rather than as two disparate types supporting the demarcation of different technocomplexes. The presence of end scrapers in Dry Creek C1 and Walker Road C1 and their relative absence in Dry Creek C2[3] has been used to differentiate the Nenana Complex from the Denali Complex (Powers

[3] The morphological distinction between "end scrapers" in Dry Creek C1 and "transverse scrapers" in Dry Creek C1 and C2 is ambiguous. *End scrapers* are described as follows: "scraper edges are on the distal ends of the flakes and the edges are transverse to the axes of the flakes" (Powers 1983:73). *Transverse scrapers* are described with "a straight or convex working edge which is transverse to the axis of the flake. The working edge lies at the opposite end of the flake from the bulb of percussion" (Powers 1983:158).

and Hoffecker 1989). However, end scrapers are found in other Denali components such as Panguingue Creek C2 (Goebel and Bigelow 1996), Whitmore Ridge C1 (West et al. 1996c), Healy Lake (Cook 1969), Donnelly Ridge (West 1967, 1996), and Gerstle River C3 (this dissertation). In sum, without a detailed examination of the range of variation in bifacial forms and intrasite analyses similar to that performed by Hoffecker (1985), a demarcation between Nenana and Denali Complexes are difficult to sustain.

The Denali Complex, first defined by West (1967; see also 1981, 1996) was constructed on the basis of a number of recurring artifact types. These include biconvex bifaces (interpreted as knives), flattened end scrapers, large blades, wedge shaped microblade cores rejuvenated through removal of core tablets perpendicular to the platform, microblades, multiple burins made on flakes, burin spalls, and boulder spall scrapers (West 1967, 1975). West later combined all early microblade producing complexes, including American Paleoarctic (Anderson 1970, 1988) and Denali Complex into a Beringian Tradition (West 1996).

Components assigned to the Denali Complex include Dry Creek C2, Swan Point CZ 4a and CZ 4b, Gerstle River C2 and C3, Panguingue Creek C2, Moose Creek C2, Broken Mammoth CZ 2, Healy Lake Chindadn, Phipps Site, Whitmore Ridge, Sparks Point, Delta River Overlook C1 and C2, Chugwater C2, Campus, and Little Panguingue Creek. On the basis of temporal and spatial contemporaneity with microblade components in the Tanana and Nenana Basins, Mason et al. (2001:526-529) include a number of non-microblade components within the Denali Complex, e.g. Carlo Creek C1, Eroadaway, Houdini Creek, Owl Ridge C2, and Teklanika West.

The Northern Paleoindian Tradition was developed by Dixon (1999, 2001) on the basis of "fluted projectile points and related lanceolate forms" and the absence of microblade technology (1999:181, 183). Again, this definition suffers from the same lack of precision in typology as the Nenana Complex and does not adequately address intrasite variability. Components assigned in the Northern Paleoindian Tradition in Interior Alaska include Owl Ridge C2, Broken Mammoth CZ 3, Swan Point CZ 3, Panguingue Creek C1, Eroadaway, Carlo Creek, and Jay Creek Ridge (Dixon 1999:182). Dixon also includes Mesa, Spein Mountain, and Putu/Bedwell, but these have been assigned to the Mesa Complex within the Northern Paleoindian Tradition, defined on the basis of a number of assemblage and technological attributes by Bever (2000, 2001a; see also Kunz and Reanier 1994, 1995, Reanier 1995; Kunz et al. 2003).

Both terms describe short-axis beveled flakes. No photographs or line drawings are presented in Powers et al. (1983) for transverse scrapers for C1 (containing both transverse and end scrapers).

The cultural affiliation of Early Holocene Tanana and Nenana valley components like Owl Ridge C2, Broken Mammoth CZ 3, Swan Point CZ 3, Panguingue Creek C2, Houdini Creek, Erodaway, and Carlo Creek have been treated tentatively and sometimes ambiguously in the literature. These early Holocene components have alternately been assigned to a later representation of the Nenana Complex (Dixon 1993), to the Denali Complex (Mason et al. 2001), or to the Northern Paleoindian Tradition, along with Mesa, Spein Mountain, and Jay Creek Ridge (Dixon 2001).

In the recent literature, there are two different interpretations of microblade technology with respect to the understanding of human adaptation in the colonization of eastern Beringia in the terminal Pleistocene. The first interpretation is that "pre-microblade" population(s) colonized Alaska first separately from later microblade-using population(s) (Powers and Hoffecker 1989; Goebel et al. 1991; Hoffecker et al. 1993), and subsequently either died out, continued south into central North America as Clovis, or became incorporated in later groups. The second interpretation is that the first migrations into eastern Beringia were by small populations using (in part) microblade technology derived from the Siberian Diuktai Culture (Cook 1969; West 1996; Holmes 2001). These populations utilized both microblade and bifacial technology, and proposed Nenana Complex and other non-microblade sites in the Interior represent functional or seasonal manifestations of this overall technology, including the variable presence/absence of microblades, cores, and burins.

I argue that microblade technology is only one portion or subset of the technological systems present in Interior Alaska from 12000 to 6000 BP. This argument rests on four empirical foundations. First, numerous assemblages with and without microblade technology are present in the same local areas with overlapping dates. Second, within the sites with the largest excavation areas (Dry Creek and Healy Lake Village) there are artifact concentrations with and without microblade technology. Third, the temporal span of microblade technology indicates its presence from the earliest occupations in Alaska and throughout much of the Holocene. Fourth, the archaeological traditions in eastern Siberia and the Russian Far East overwhelmingly exhibit microblade technology. Understanding how technology was used in this region requires a different approach, incorporating technological, economic, and spatial analyses. Intrasite patterning among microblade and other technologies as represented by debitage and discarded tools at Gerstle River are explored in Chapters 7, 8, 10, and 11.

Excavations, Sample Size, and Interpretation

Much of the archaeological literature for Interior Alaska has been influenced by the results and interpretations of relatively few excavations. Most of the recent literature relies on ten or fewer sites to develop or summarize explanations of prehistoric settlement systems and subsistence strategies (cf. Bever 2001a; Clark 2001; Dixon 2001, 1999, 1993; Hamilton and Goebel 1999; Hoffecker et al. 1993; Pearson 1999a; Pearson and Powers 2001; Yesner 2001, 1996). These sites almost invariably include Dry Creek, Walker Road, Broken Mammoth, Swan Point, Healy Lake and Campus, for which only Campus, Dry Creek and Healy Lake have site reports, although the latter two remain unpublished (Mobley 1991; Powers et al. 1983; Cook 1969). The Campus site report suggests a Mid-Holocene age for Denali Complex material (Mobley 1991). A recently recovered radiocarbon date of 6850±70 BP (Beta-97212) associated with microblade technology has been reported by Pearson and Powers (2001). However, with the presence of notched bifaces and other mid-Holocene forms, the site apparently contains multiple components that are probably mixed due to cryoturbation (Mobley 1991).

A closer inspection of these excavations reveals disparities between site data and explanations. For instance, a number of investigators have used Dry Creek C2 to exemplify Denali Complex materials in the context of abundant microblade technology (e.g., Hamilton and Goebel 1999). Furthermore, Dry Creek is used to demarcate differences between a microblade Denali Complex and a non-microblade Nenana Complex (Goebel 1990; Hoffecker et al. 1993). However, the spatial patterning clearly shows that only 36% of the lithic clusters contain microblades. Goebel (1990) compared the entire Dry Creek C2 lithic assemblage with Dry Creek C1 and Walker Road, along with two Clovis sites, and suggested technological correlations between Nenana and Clovis. However, much of the differences were related to variable presence or absence of microblades, microblade cores, and burins. A hierarchical cluster analysis of tool classes shows that Dry Creek C1 assemblage actually clusters more with the non-microblade C2 clusters than the latter do with microblade C2 clusters (Potter 2000, 2004b; see Chapter 8). Clearly, the assemblage variability at Dry Creek C2, the largest of the excavated sites (in terms of area and number of items) for the Late Pleistocene/Early Holocene, indicates that other factors, such as seasonality, subsistence strategies, and settlement systems could influence the patterns of co-occurring tool types discarded in various settings. Furthermore, the presence of components with and without microblades in close temporal and spatial proximity does not support the contention of separate technological systems (e.g., components at Panguingue Creek, Erodaway, Houdini Creek, Carlo Creek, Dry Creek, Moose Creek, Owl Ridge).

Drawing conclusions from limited samples is speculative at best, especially when a large number of other sites are potentially available for examination. Numerous sites have been tested and have pertinent data in the form of features, formal tools, and/or associated radiocarbon dates. These sites are generally found in the gray literature or in CRM reports, but all are available at the Alaska State Office of History and Archaeology. These sites include FAI-045 (Dixon et al. 1980), Mead (XBD-071), Rainbow Lake (XBD-106), Delta Creek (XBD-110), Delta River Overlook (XMH-297) (Holmes 1979; Bacon and Holmes 1980; Holmes 2001), Hurricane Bluff (XMH-838), Little Delta River #3 (XBD-167), Little Delta River #4 (XBD-183) Owl Knoll (XMH-839) (Higgs et al. 1999), North Gerstle Point (XBD-163), (VanderHoek et al. 1994), Houdini Creek (Bowers et al. 1995), Erodaway (Holmes 1988), Butte Lake (Betts 1987), and HEA-327 (Reuther et al. 2003). Intersite analyses using a large dataset have resulted in a number of patterns of technological, settlement, and land use changes, especially for the later Holocene (Potter 2000, 2004b).

An illustrative case in point would be the presentation of the data from the two oldest components in Beringia, Swan Point CZ 4 and Broken Mammoth CZ 4 (Holmes 1996; Holmes et al. 1996). Hamilton and Goebel (1999:170) argue that the Swan Point assemblage, specifically the presence of microblade technology, is "inconsistent with cultural inventories from all other deeply buried sites of this age in the Nenana and Tanana valleys." There are at present only three securely dated components within this time frame (12000-11500 BP) in Alaska, Swan Point CZ 4, Broken Mammoth CZ 4, and Mead CZ 4. Microblade technology is present in the first, absent in the second, and unclear given the limited testing in the third. Swan Point CZ 4 has a much larger sample size of lithic tools than Broken Mammoth CZ 4 (Holmes 2004, personal communication; Holmes 1996); the latter has very few formal tools of any kind. Hamilton and Goebel (1999:170) further note that Swan Point predates "all known microblade industries in western Beringia."

However, this is not an argument supporting an inconsistency with respect to the Nenana record, it is simply a reflection of the data. Furthermore, only one other site (Ushki 1, Level VII) dates to before 11000 BP in addition to the three components mentioned (Goebel et al. 2003). Hamilton and Goebel (1999:170) assert that "perhaps the microblades and related flakes were mixed with older charcoal and other cultural materials during and immediately after deposition of the thin sheet of colluvial detritus and before loess accumulation began at the site" (1999:170). They ignore the fact that the CZ 4 artifacts are clearly stratigraphically below CZ 3, dating to over 10000 BP. There is no evidence of turbation at this colluvial layer (i.e., artifacts are horizontal and not inclined). In addition, several radiocarbon dates on different materials support the dating of this component. Hamilton and Goebel (1999:170) opine that "[a]lthough a tusk fragment was found directly above a microblade, clear evidence for scavenging of old ivory at the Broken Mammoth and Mead sites demonstrates that this association cannot provide any direct age or age limit on the microblades at Swan Point." What is avoided in this argument is that this tusk date is identical to the other radiocarbon dates for this component, including a date from organic material taken directly from a lithic artifact (see Holmes 1998b). Hamilton and Goebel (1999:170) do offer supporting points for the age of Swan Point CZ 4, such as lack of cryoturbation and lack of artifact mixing in the loess between CZ 3 and 4, and loess accumulation rates suggesting over 1000 years separating CZ 3 and CZ 4. The lines of argument supporting the validity of the CZ 4 component and its dating are clear and convincing. There is a strong correlation between stratigraphy and radiocarbon dates (no reversals, etc.). There are clear associations among radiocarbon dates and the artifacts (organic residue, etc.), which stands in stark contrast to the oldest Broken Mammoth CZ 4 radiocarbon dates.

The Broken Mammoth associations among dated samples and the archaeological materials are somewhat less convincing. There is a wide dispersal of dates within CZ 4, assuming it represents a single component. The two 11700 BP radiocarbon dates were collected as scattered charcoal fragments, not from within hearths (Holmes 2003, personal communication). The only hearth dates for CZ 4 are 11420±70 BP (CAMS-5358) and 11510±120 BP (WSU-4262). In addition, collagen from ivory and a swan bone were dated to 11500±80 BP and 11540±140 BP. Taken together, a convincing case could be made for the dating of CZ 4 to around 11500 BP. However, most reviewers note the earliest dates (11700 BP), and Goebel et al. (2003:504) stated it was the oldest component in Beringia.

Whether or not Broken Mammoth CZ 4 or Swan Point CZ 4 represents the oldest component in Beringia is irrelevant here, the point is how conclusions are derived from the archaeological data. Inferences at the level of component or site should incorporate spatial analysis and be evaluated on the basis of site structure, including (1) the detailed relationships of dated samples to the archaeological remains, and (2) delineation of components and occupations on the basis of stratigraphy and spatial patterns of artifacts, features, and fauna. At present, it is unclear if there are one, four, or more components under the rubric of "Broken Mammoth CZ 4."

Typological Considerations

Another important issue in Interior Alaskan archaeology is our typological demarcation and understanding of different tool classes and types. Detailed typologies have not been undertaken for this region, though some work along these lines has been done in adjacent Yukon Territory (Morlan 1973a; Workman 1978; Gotthardt 1990; Clark and Gotthardt 1999). Beyond a few types like Kavik points (Derry 1972) and Chindadn points (Cook 1996, Holmes 2001), very few other diagnostic tool types have been developed to aid workers investigating assemblage variability. Essentially, two basic categories have emerged for evaluating Late Pleistocene and Early Holocene archaeology: Chindadn points and variable presence/absence of microblade technology. While a number of studies have examined the technological variability in burins (Mauger 1970), microblade cores (Yoshizaki 1961; Sanger 1968; Hayashi 1968; Cook 1968, 1969; Kobayashi 1970; Mauger 1972; Powers 1983; Flenniken 1987; Clark and Gotthardt 1999), and microblades (Owen 1988), to date there have been few studies on bifacial points dating to this time period in the Interior (see Holmes 2001 for a rare example). Admittedly, the sample size is small, but then I argue that interpretations about different populations or cultures on the basis of this sample size should be very tentative and conservative with respect to splitting and lumping.

Regarding microblade technology as a "cultural diagnostic," the data indicate that this technology is present from the earliest dated assemblage in Alaska (Swan Point CZ 4) through the Holocene to about 1000 BP (Potter 2000, 2004b). A total of 35% of all dated components in Interior Alaska (n=241) contain microblade technology. Wedge shaped microblade cores also do not appear to be temporally diagnostic, and are found from early assemblages (including Swan Point CZ 4) to late Holocene assemblages (Broken Mammoth CZ 2). Tabular or Tuktu cores seem to have a more limited distribution, and generally only appear later than 5000 BP.

Basic typological studies are necessary in order to document the nature of the variability in these items. However, given the technological conservatism in Interior Alaskan assemblages, with microblades, wedge shaped and sub-conical microblade cores, flake burins, transverse scrapers, various lanceolate biface forms, and boulder spall scrapers present throughout, I argue that we must also examine tools using other approaches (Potter 2004b). Presently, we know very little about how lithic tools (including microblades) were used in systemic contexts in this region. Very few usewear studies have been conducted to date in the region (most notably Mobley 1991; Del Bene 1980; Flannigan 2002). Site structure and organizational studies, similar to that conducted on Dry Creek C2 by Hoffecker (1983a, b) and Walker Road C1 by Higgs (1992) are necessary to develop and test hypotheses about site use, tool use, and ultimately settlement systems and subsistence strategies. This dissertation examines various technological problems in the context of site structure and organization.

Cultural Frameworks

A typical Alaskan archaeological practice is to construct "cultural" entities (e.g., Paleoindian, Denali, Northern Archaic) at the level of Tradition, Phase, or Complex in order to understand technology, subsistence, and settlement systems with respect to the environment *sensu latu*. There have been a number of cultural chronologies used to interpret cultural history in Interior Alaska. In some cases, they are variations on a common theme (Bacon 1987). The first widely used system was delineated by Cook and McKennan (1970). Other cultural chronologies include Cook (1975), Dixon (1985, 1999, but see Bacon 1987), West (1981, 1996, but see Maschner 1997), Holmes (2001), and Holmes and Cook (1999).

Presence (or absence) of a few technological traits is sometimes used to discriminate different cultures or complexes. In this approach, the variability of the record is severely underestimated, as it does not adequately address time, space, assemblage structural, site structural, ecological, and other variables that can effect the formation of archaeological assemblages.

I argue that we should not rely totally on essentialist and typological models that do not reflect intersite variability (e.g., Dixon 1985, 1999; Anderson 1988; Stone and Yesner 2002). Values of central tendency *and variability* should be explicit in models of site function and tool use. Emergent features of intersite patterns should be studied at relevant organizational levels. Differences of kind, degree, and constellation (or array) should be heuristically examined by integrating intersite studies with detailed site-specific analyses.

Due to the limited number of excavated sites, typical excavation objectives, lack of explicit typologies, and cultural framework limitations, a number of important site structural issues remain unresolved for the Late Pleistocene and Early Holocene in Interior Alaska. We have only limited models of settlement system, the most influential is that proposed by Guthrie (1983a) of base camps and spike camps, of which only the latter have been found (see Chapter 11). Some studies have examined the relationships among different site types for the late prehistoric period (Shinkwin et al. 1980), but almost no attempt has been made to explicitly develop and test site typologies for earlier periods (see Potter 2000, 2004b).

Previous Work in the Middle Tanana Basin

The following section briefly summarizes past archaeological research within the Tanana Basin, from the 1930s to the present. The purpose of this list is to provide support for the argument that compilation of existing data sources can be useful in assessing site structure and developing models for site use and landscape use. In addition, the standard argument of "we need more data," is belied by the rich extant data sources and the lack of site structural investigations to date.

There have been relatively few excavated early prehistoric sites in this region, and nine (other than Gerstle River) have excavations greater than 10 m^2. The earliest archaeological excavation in Interior Alaska was at the Campus site (FAI-001) from 1933 to 1936, recovering materials resembling ancient stone tools from northeastern Asia (see Nelson 1935, 1937; Rainey 1939, 1940; Mobley 1991). The Campus site was also excavated in 1966 and 1995 (Hosley and Mauger n.d, Mobley 1991, Pearson and Powers 2001). Dixthada (TNX-004), with a recent Athabaskan component, was excavated in 1936, 1962 and 1965 (Rainey 1939; Shinkwin 1979). Healy Lake Village and Garden sites (XBD-020 and XBD-204), multicomponent site near Gerstle River, were by Cook in 1966-1967, and 1969 (Cook 1969). Donnelly Ridge, a near surface site in alpine tundra, was excavated in the 1960s (West 1967). Chugwater (FAI-035), another multicomponent site with shallow stratigraphy was excavated in 1975 by Cook, surveyed in 1978 and 1981, and excavated in 1982-1988 (Yarborough 1978; Steele 1981; Aigner and Lively 1986; Maitland 1986; Lively 1988). The Tok Terrace (TNX-033) site was excavated in 1988-1990 (Sheppard et al. 1989; Gerlach et al. 1990; Sheppard et al. 1991). Broken Mammoth (XBD-131) was discovered in 1989 and excavated in 1989-1991, 1993, 1997-1998, 2000, and 2002 (Holmes 1996). Swan Point (XBD-156) was discovered in 1991 and excavated in 1991-1993, and 2002-2003 (Holmes et al. 1996; Crass and Holmes 2003).

Apart from this first tier of often-cited archaeological sites, there are a number of lesser-known localities in the Tanana basin with associated radiocarbon dates that offer important data (listed above). These sites and others are further discussed in Chapter 8. Surveys and investigations in this region are listed chronologically below.

The earliest reports relating to cultural resources were from explorers in the late 19th and early 20th centuries (e.g., Allen 1887; Abercrombie 1899; Mendenhall 1900). The first archaeological research in the region occurred from the 1930s to the 1960s (Nelson 1935, 1937; Rainey 1939; Giddings 1941; Johnson 1946; Skarland and Giddings 1948; Johnson and Raup 1964; Kegler 1966). Rainey (1939, 1940) investigated several sites in the Tanana Basin, including Dixthada and Campus. Johnson surveyed the Alaskan/Richardson Highways from Fairbanks to the Canadian border in 1944, noting two sites (Johnson 1946). In the 1960s several sites in the Delta River area were investigated by West (1967, 1996) and Reger (et al. 1964), including one of the type sites of the Denali Complex, Donnelly Ridge. West also surveyed around Livengood (Kegler 1966) and excavated at Dixthada in 1965 (Cook 1969). Cook (and McKennan) investigated Healy Lake between 1966 and 1972, excavating 383 m^2, making it the largest excavation in the Interior (Cook 1969, 1989).

Most pre-1970s surveys are oriented toward academic research, whereas most post-1970s surveys are the products of cultural resource management (CRM) surveys related to development or agency inventories. A number of these surveys have been described in Potter et al. (2002). The Trans-Alaska Pipeline System (TAPS) project generated large multi-year archaeological investigations by the University of Alaska Fairbanks Department of Anthropology and Institute of Arctic Biology in the 1970, 1971, 1974, and 1975 field seasons (Cook 1970, 1971, 1976, 1977). Over 300 sites were located and tested or excavated in preparation for the pipeline construction (see Potter 2001b). Reports by Solka (1970) and studies sponsored by Native organizations (Andrews 1977) led to the identification of many archaeological sites in the region. Various state and federally sponsored archaeological surveys were conducted throughout the 1970s (Dixon and Johnson 1973; Dixon and Bowers 1974; Workman and Holmes 1974; Yarborough 1975, 1978; Holmes and Dilliplane 1976; Rabich and Reger 1978; Bacon 1978; Plaskett 1978; McCay 1979; McCay and Sorenson 1980; Sorenson and Johnson 1980; Thurston 1981). The proposed Alaska Natural Gas Transportation System (ANGTS) project resulted in a multi-year study by the University of Alaska Fairbanks of numerous sites in the Interior (Aigner 1979; Shinkwin and Aigner 1979; Aigner and Gannon 1981a, 1981b). Most of the sites recorded by these surveys were never excavated, and few radiocarbon dated or subsurface sites were observed. However, excavations were undertaken at Dixthada (Shinkwin 1979).

During the last 25 years, numerous CRM and academic related investigations were conducted in the Interior. Four important Tanana Basin sites, Broken Mammoth, Swan Point, Chugwater, and Tok Terrace were excavated during several field seasons in the 1980s and 1990s (Maitland 1986; Lively 1988; Holmes 1996; Holmes et al. 1996; Sheppard et al. 1991). Other surveys in the region include U.S. military sponsored work (Holmes 1979; Bacon and Holmes 1980; Dixon et al. 1980; Bacon 1980; Steele 1980, 1982, 1983; U.S. Army COE 1993; Gerlach et al. 1996; Higgs et al. 1999; Potter et al. 2000b; Hedman et al. 2002; Potter et al. 2002), other state, federal, and Native sponsored CRM investigations (Klingler 1982; Hoff 1982; Holmes and McMahan 1985; Dale and Holmes 1988; Kunz 1992; Pearson 1999b; Sheppard 1999, 2001), and private development related investigations (Dixon and Sattler 1992; Dixon et al. 1993; Higgs 1996; Higgs et al. 1997; Higgs 1997; Higgs 1998; Potter et al. 2002). A recent development-related survey resulted in the discovery of over 120 sites, including 20 prehistoric sites in the Tanana basin (Potter et al. 2002).

To date, there are 365 prehistoric and historic Native sites in the Tanana Basin, not including 182 sites in the Nenana-Kantishna Basin and 368 sites in the Tangle Lakes region. A total of 63 dated components exist for the Tanana Basin, 33 for the Nenana-Kantishna Basin, and 19 for the Tangle Lakes region. A portion of this dataset is explored in Chapter 8.

Ethnography

A number of important ethnographic data sources are available for the Upper Tanana region, from the Salcha River to the Canadian Border along the Tanana River (Osgood 1936; McKennan 1959, 1969a, 1969b, 1981; Olson 1968; Vitt 1971; Pitts 1972; VanStone 1974; Andrews 1975; Shinkwin et al. 1980; Mishler 1986; Simeone 1995; Gerlach 2000). The summary presented here focuses on settlement, subsistence, and technological aspects of the Upper Tanana Athabaskans.

Tanana Athabaskans are typically divided into three groups, the Upper Tanana, Tanacross, and Lower Tanana (McKennan 1981). The population of the Tanana region in the late 1800s ranges from 400 to 700 (Petroff 1900; Allen 1887; Brooks 1900). There were five regional bands in the Upper Tanana area; these were composed of exogamous matrilineal descent groups (McKennan 1969a, 1981). Each band had a headman assisted by a second chief.

Table 3.4 summarizes the settlement and subsistence patterns in the Upper Tanana region, and the following summary is derived from McKennan (1959, 1969a, 1969b, 1981), Pitts (1972), Vitt (1971), Mishler (1986), and O'Brien (1997). The most important food staple of the Upper Tanana Athabaskans was caribou, and while salmon was important in the Goodpaster and Salcha River areas, it was not as important further upstream. This demarcation between salmon presence downstream from the Goodpaster River and absence upstream is reflected in the Lower Tanana and Tanacross language spatial distribution. In the winter, winter camps, located in the uplands, were occupied, and subsistence relied on cached supplies and freshwater fishing. In the spring, populations would move to fishing spots nearer to the main river where moose, caribou, and small game were hunted and snared. Fish camps were inhabited most of the summer where freshwater fish (and salmon downstream from the Goodpaster River) were captured with cylindrical fishtraps and dip nets and stored in underground caches. In late summer and fall, people would disperse and hunt caribou, sheep and small mammals in the uplands. The fall caribou hunt was especially important, where migrating caribou offered the main source of dried meat that allowed survival over winter. Caribou fences and fish weirs were labor intensive to construct and operate, and acted as centers for collective labor.

Weapons consisted of birch bows and a variety of arrow types, including antler, bone, wood, or copper serrated points for moose, caribou, and sheep and blunt arrows for birds (see O'Brien 1997). Exploitation methods for small game included snares and deadfalls. Fish were captured in cylindrical traps or through 3-pronged leisters with serrated tines. Other tools commonly constructed included adzes, mauls, pestles, semi-lunar scrapers (boulder spall scrapers) were made of ground or fractured stone. Crooked knives, drills, fleshers, beamers, awls, and bindings were made from various organic materials, such as bone, antler, teeth, sinew, wood, and spruce roots. Clothing was generally manufactured from tanned caribou skins.

Terrestrial travel was usually either via walking, snowshoeing, or sledding with baggage situated on sleds. Dogs were not traditionally used for packing or pulling sleds. Water travel commonly used relatively small birchbark canoes and moved via single paddles or poles. Sometimes, skin-covered boats were used for carrying cargo downstream.

Table 3.4 Summary of settlement and subsistence patterns in the Upper Tanana region (19th century).

Season	Settlement	Resource	Exploitation Method
Winter	Winter camp (located in uplands)	Dried caribou meat	Cached
Spring (before snow melt)	Moved to fishing spots nearer main river	Moose, Caribou (spring migration) Muskrat, beaver	Hunted, snared moose Intercepting caribou on northward migration through timber, muskrat and beaver
June	Fishing spots (camps)	Whitefish started running up clearwater streams to spawn	Cylindrical fishtraps, large dip nets at weird built across streams (generally near outlets of lakes) (fish dried and stored in underground caches)
After fishing season		Berries, roots, ducks	Blunt arrows during molt
Late summer	Move to Caribou fence areas	Sheep Marmots, ground squirrels	Trip to mountains for meat and skins for winter moccasin-trousers. Women snared marmots, goround squirrels
Fall (Late august)	Near winter camp	Fall caribou hunt	Caribou fences: a. long fence set with snares, or b. two long fences, converging to form corral, trapped animals were killed with lances or arrows

Food was normally cooked by men, including roasting over an open fire or broiling in birchbark containers with heated rocks. Bone marrow and grease were both acquired from large game. Grease was rendered through boiling.

Two distinct house forms were constructed by the Upper Tanana, (1) the Ch'edheth zhax (skin house), a temporary single family tent made from long peeled spruce poles tied together with a covering of sewn moose or caribou hides, and (2) Dlaat zhax (moss house), a large semi-subterranean 3-4 family residence made with a pole frame, spruce bark walls, a gabled moss roof, a sleeping bench, central hearth, and a skin door (Mishler 1986:29). The moss house was used in winter camps, while the skin houses and other tent forms were used for transit camps. Other structure forms include bark covered huts at fish camps and domed sweathouses separate from residences (Pitts 1972).

The relationship between recorded ethnographic patterns of subsistence and settlement patterns with the archaeological record has been documented to about 700 years in the Interior (see Potter 1997, 2004b; compare with Dixon 1985). In two studies examining intersite variability among a large sample of prehistoric sites in the Upper Susitna region, Potter (1997, 2000, 2004b) found that around 700 BP, assemblage structure decreased in diversity and size, features like firepits and depressions (caches and house pits) increased, increased presence of storage features, absence of various tool classes, decrease in flaked stone technology, much lower frequencies of sites on overlooks, increasing occurrence of moose and sheep, and increasing site occurrence in caribou fall concentration areas. Overall, the ethnographic pattern of Athabaskans seems to be present only from around 700 years ago.

Ethnogeography

Ethnogeography is one avenue for exploring traditional uses of landscapes, and as interpretations of site function and use at Gerstle River are an important aspect of this dissertation, examining recent traditional land use patterns in the site vicinity is warranted. Placenames for the Gerstle River area are provided in Table 3.5.

A number of toponyms were described by Mishler (1986) for the region between the Salcha River and Dot Lake along the Tanana and adjoining rivers. Some ethnogeographic names may relate to freshwater fishing activities, namely Nghaal Menn' (Lake George, trans. "big whitefish lake"), Taats'ede Menn' (Twelvemile Lake, trans. "sucker [fish] lake"), and Ts'aadleey Ndiige (Healy River, "whitefish creek") (Mishler 1986:123-125). A few terrestrial resources are suggested by Gah Tsoghk'ah Chen' (trans. "rabbit's shoulders fat"), a low-lying area east of the Johnson River, and Udzih Ddhel' Nda' (Berry Creek, trans. "caribou mountain creek"), the river located eight miles east of the Johnson River.

Intriguingly, a few names are suggestive of archaeologically significant discoveries. Yeehchox Tth'en (trans. "big animal bone") refers to a mountain near the Volkmar River, perhaps referring to mammoth or other Pleistocene remains (Mishler 1986:123). Daadiidhogh Ddhel' (trans. "stone scraper tool mountain") refers to a mountain along the ridge to the northeast of Healy Lake, about 30 miles northeast of the Gerstle River site (Mishler 1986:123).

The preponderance of names in this region is near Healy Lake and the other lakes just north of the Tanana River, suggesting that much of the ethnographic focus may have been on resources exploited in these areas. Relatively few named features are present for the upland areas south of Gerstle River, suggesting less intensive use. No names are present for the area of the northern foothills of the Alaska Range west of Gerstle River suggesting that that river may have been an important economic boundary in the recent past.

Table 3.5 Placenames near Gerstle River (data from Mishler 1986:122-127).

Toponym	*English name*	*Literal Translation*	*Notes*
Gah Tsoghk'ah Chen'	N/A	"rabbit's shoulder fat"	Low lying area between Horn Mountain and the Tanana River.
Haataal Ndiige	Clearwater Creek	"warm water creek"	An underground warm spring in the area results in open water during the winter. Five prehistoric sites were found nearby (XBD-026, 082, 083, 084, 085).
Keelt'aaddhe Menn'	Moose Lake	"lily pads lake"	
Mendaes Chaege	Healy Lake Village		The modern village at Healy Lake.
Mendaes Chaege Menn'	Healy Lake	"shallows lake mouth lake"	Several prehistoric and late historic sites were found around the lake (XBD-020, 021, 022, 204, 205, 206, 207, 208, 209, 210, 211, and 212).
Nghaal Menn'	Lake George	"big whitefish lake"	Five prehistoric and historic sites were found on the north shore (XMH-213, 214, 215, 216, 217).
Shos Ddhel'	Independence Ridge	"bear mountain"	
Shos Ddhel' Chaege	N/A	"mouth of bear mountain creek"	
Shos Ddhel' Ndiige	Little Gerstle River	"bear mountain creek"	
Taat'ees Menn'	Black lake	"black water lake"	
Taats'ede Menn'	Twelvemile Lake	"sucker lake"	Named after the sucker fish.
Teyh Ch'ech'edze	Old Healy Lake Village	"kidney" or "calf of leg" hill	At northern end of Healy Lake (XBD-021)
Ts'aadleey Ndiige	Healy River	"whitefish creek"	
Ts'iitsiih Ndiige	Gerstle River	"long thin strip of wood creek"	Tanana Athabaskans used thin peeled wood strips as sandpaper on their wooden gear, called ts'iits'ih.
Tth'itu'	Tanana River	"main river"	
Xeetii Menn'	Hidden Lake	"long and wide lake"	Two prehistoric sites were found on the north shore (XMH-209, 210)
Niithaayh Ndiige	Johnson river	"sandy, gravel bed river"	This is also the name of the Delta River.

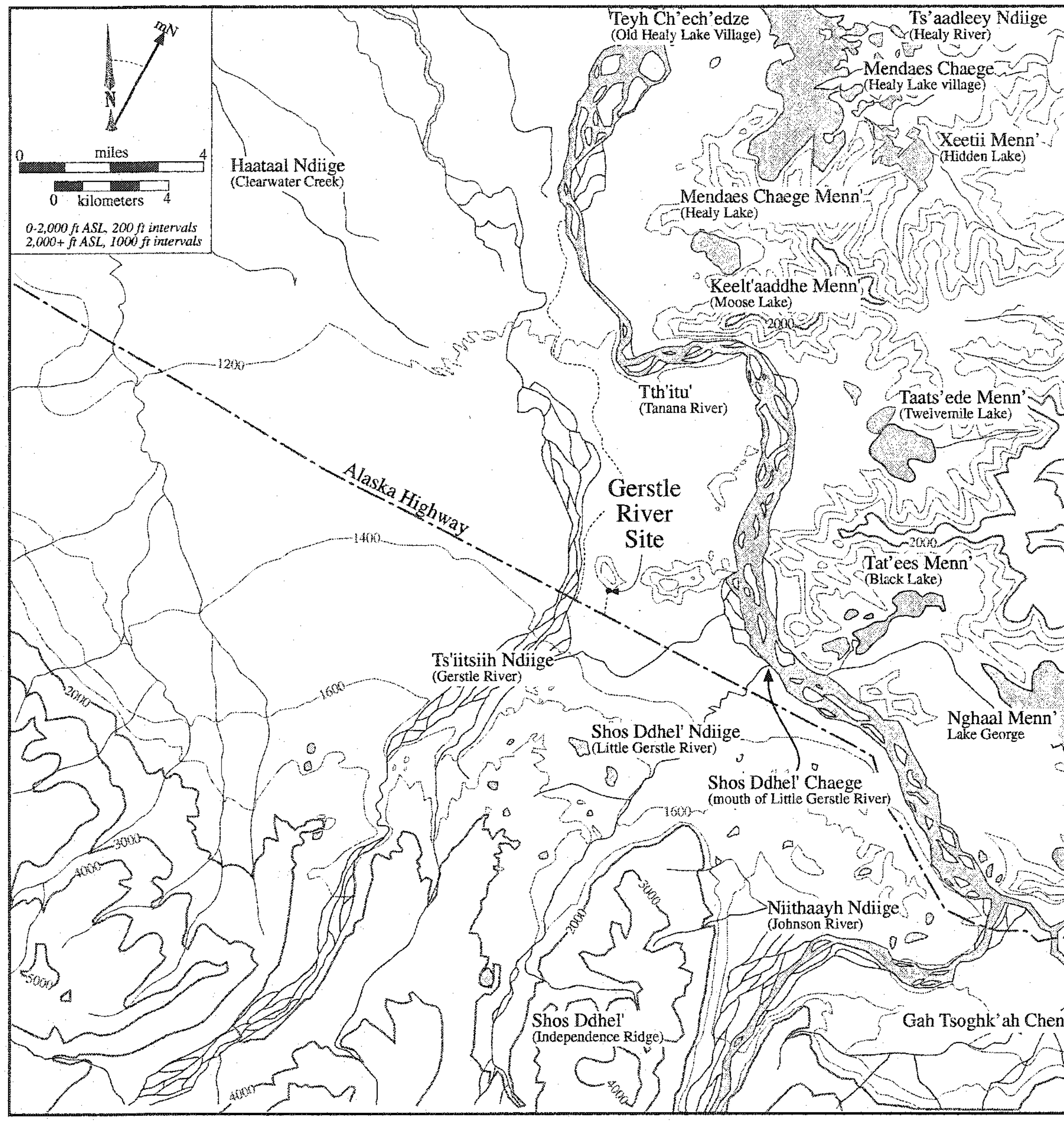

Figure 3.6 Native placenames near Gerstle River.

History of Disturbance

Because the Gerstle River site area has been quarried extensively in the past, it is critical to understand and trace the development of the history of site disturbance in order to place the site in an appropriate geomorphological context. To this end, I obtained all the aerial photographs that were available for the Gerstle River site area. Dates, scales and descriptions are provided in Table 3.6. The 1953, 1954, 1961, 1976, and 1998 aerial photographs were obtained at the Alaska DOT&PF office in Fairbanks. These were taken at various scales for projects relating to the area. The 1978 photograph was obtained from a series taken apparently in conjunction with the UAF archaeological survey for the proposed Alaska Natural Gas Transportation System (Aigner 1979; Shinkwin and Aigner 1979; Aigner and Gannon 1981a, 1981b). Because it is unknown if any of the aerial photographs were geo-rectified, the inferences drawn from these must be considered approximate. The photographs were scanned at 600 dpi, and oriented based on common points (intersection with Gerstle River access road with the Alaska Highway, the creek drainage south of the site, etc.). Composites of all available aerial photographs with the approximate location of the excavation units are presented in Figures 3.7-3.8.

Table 3.6 Aerial photographs of the Gerstle River site area.

Date	*Type*	*Scale*	*Labels on photographs*	*Agency*
09/09/1953	B/W	1:20,000	0003 VV 815RTS T-5 M 165A (192) 338SRS 9SEPT53 51AM-1	Unknown
05/04/1954	B/W	1:20,000	157 VV 1370PMG M 4G11 APCS 3JULY54 51AM1 BGD 191	Unknown
08/17/1961	B/W	1:12,720	17 Aug 61 3-125 (on back: 1" = 1,060', 1.72" = 1,820', Mendenhall Aerial Surveys, P.O. Box 754, Fairbanks Alaska)	Unknown
09/23/1976	B/W	1:12,000	9-23-76 1" = 1000' FL=151.97 DELTA-TOK 1 045	ADOT&PF
08/19/1978	Color	1:36,000	NWAR 28 003	Unknown
06/19/1998	Color	Unknown	6/19/98 GERSTLE QUARRY 2-5	ADOT&PF
08/28/2000	B/W	1:30,000	8-28-2000 1:30,000 153.276 NGPL 545-19 (by Aeromap, not georectified)	AGPPT

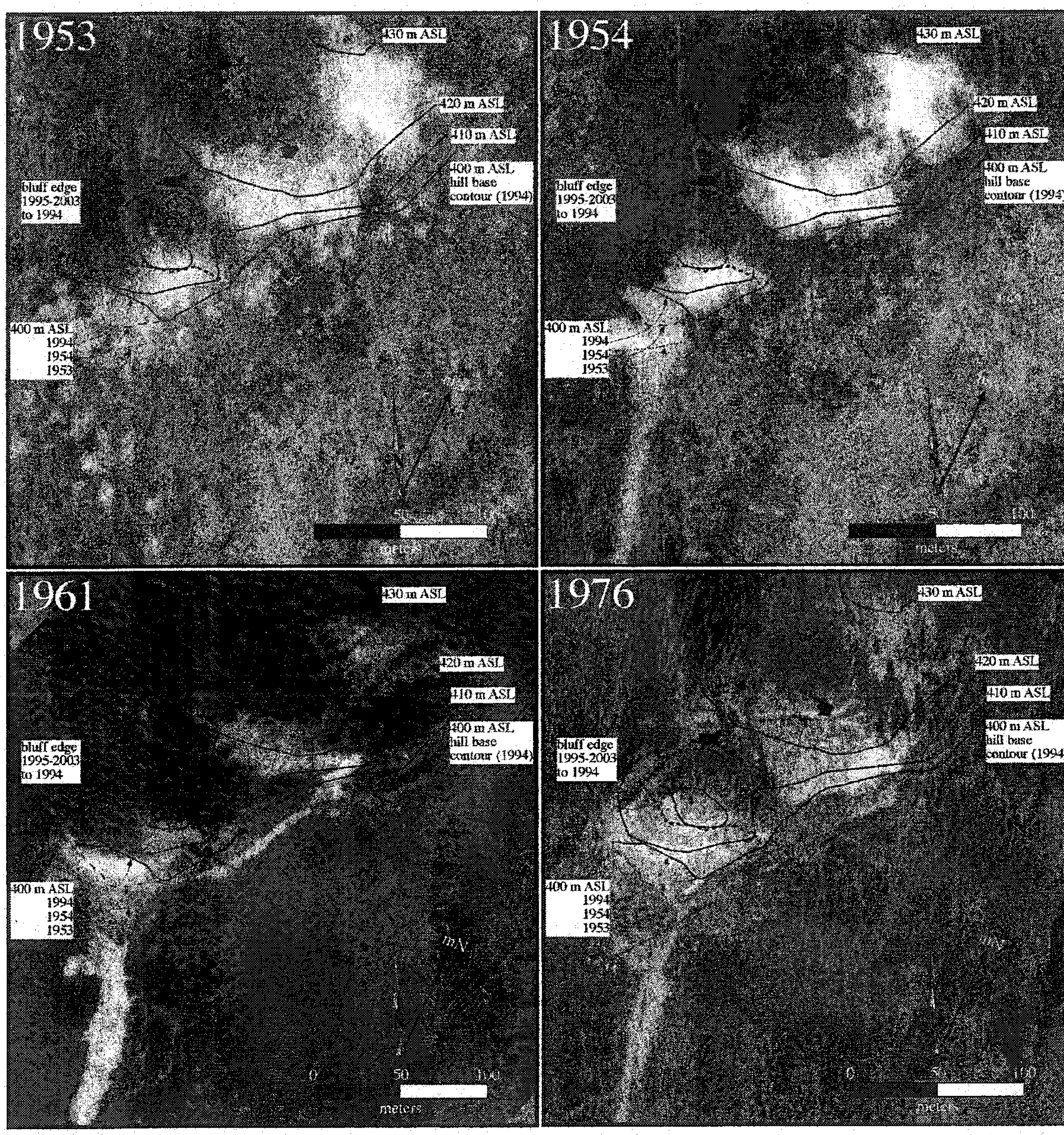

Figure 3.7. Aerial photographs from 1953, 1954, 1961, and 1976.

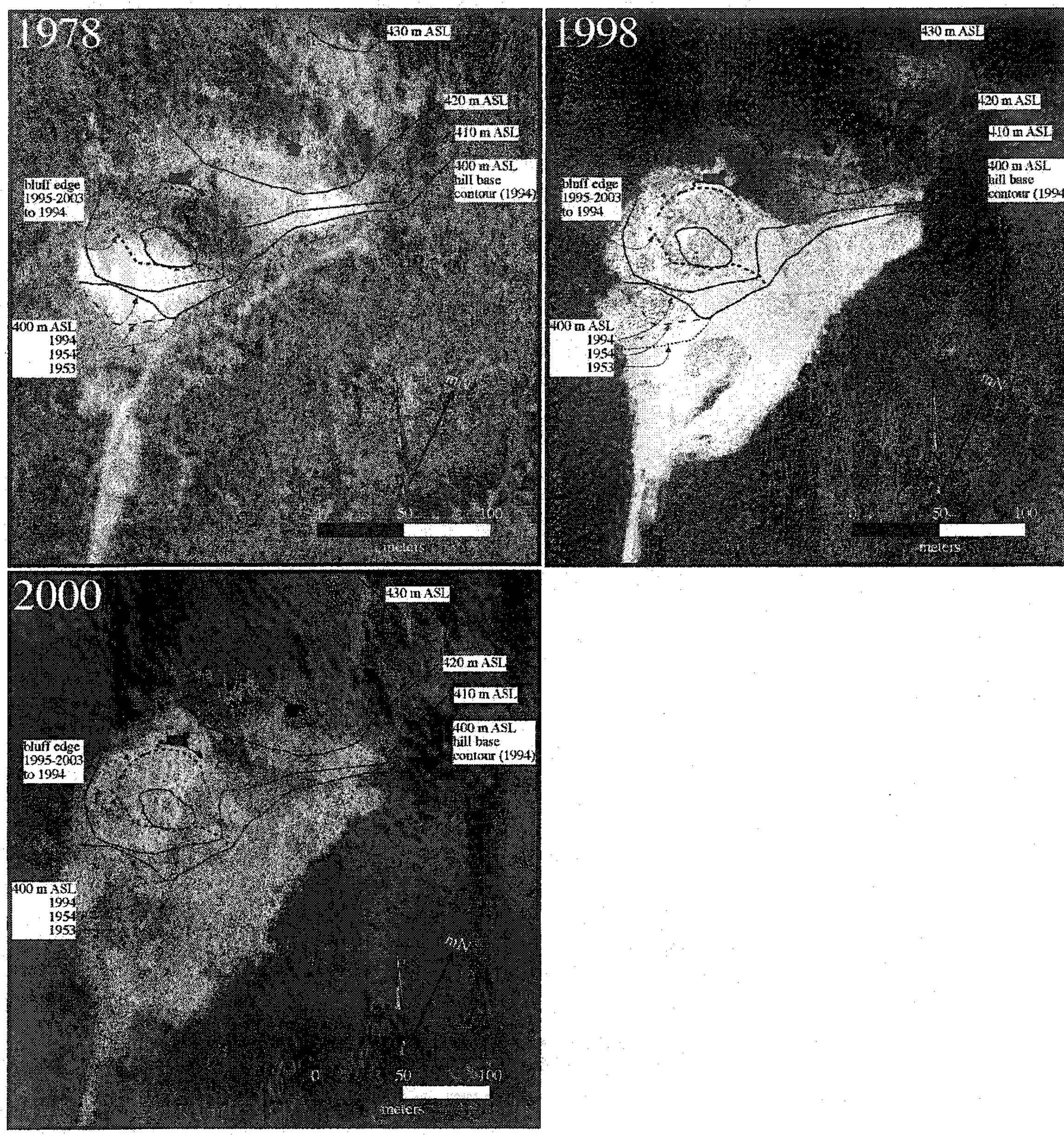

Figure 3.8. Aerial photographs from 1978, 1998, and 2000.

In addition, several topographic sketch maps were obtained at ADOT&PF in Fairbanks, including a 1962 map in Balvin (1962) and a 1994 topographic map in conjunction with the quarrying activities in late 1994 and 1995. These data were compared with the topographic map in Kimura et al. (1989), the maps produced with Transit and Total Station of the Lower Locus[4]. These were collated with a map produced with Transit mapping at the Upper Locus by Holmes (1998a). These were analyzed and mapped within Macromedia Freehand™, by scaling, rotating, and correlating common data points (datum stakes, edges of disturbed areas, access road, etc.). Because the base aerial photos were not geo-rectified and analysis within ArcView or similar GIS software was not possible, there is likely some unavoidable error in horizontal placement. Given the control afforded by aerial photographs, in some cases, highly resolved, I anticipate the error to be less than 5 meters. Given that much of the natural topography no longer exists, I believe that this is an adequate resolution to examine the questions relating to site setting of the Lower Locus.

The Gerstle River area was possibly one of many rip-rap sources used by the U.S. Army Corps of Engineers during the construction of the Alaska Highway in 1942. The history of the Alaskan Highway construction is summarized in Holmes and Dilliplane (1976:VII-1-5). While it appears that no rip-rap extraction occurred prior to 1954 based on the aerial photographs, some quarrying occurred from 1954 to September 14, 1961 when U.S. DOI, Bureau of Land Management transferred the material site to Alaska Department of Public Works, Division of Highways (non-expiring grant, FSN 025772). DOT assigned the material site number MS 62-3-075-2 to the Gerstle River Quarry. According to DOT records, since the material site was renewed with grant No. ADL 80381 in 1978 (with indefinite expiration date), various rip-rap mining occurred in 1983, 1990, 1993, 1995, and 1999. Geotechnical investigations occurred in 1962, just after transferal of the material site to the State of Alaska (Balvin 1962), and several core holes were drilled in and around the Gerstle River Quarry area in 1994 and 1999 (Solie 1999). Table 3.7 provides a list of major disturbances at Gerstle River.

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[4] Base data layers include: 2001 Trimble™ GPS data, 2001 Leica™ Total Station data, 1996 transit-based map of Upper Locus (Holmes 1998) with 1 m contour intervals, 1999 transit-based map of Lower Locus (Potter 1999) with 1-m contour intervals, all aerial photographs, 1994 ADOT&PF map of the quarry, 1989 map of the quarry with Upper Locus excavations mapped (Kimura et al. 1989). Derived layers include: vector-based contours for the Upper Locus (Holmes 1996 map, 1994 ADOT&PF map, Kotani 1989 map) and the Lower Locus (Potter 1999 map), excavation areas, history of quarrying activities, history of the bluff edge at the Lower Locus, site area estimates, and guidelines to orient the aerial photographs.

Table 3.7 History of disturbance at the Gerstle River site area.

Year	*Agency*	*Nature of Disturbance*
1954-1961	USCOE?	Access road constructed, rip-rap extraction at Quarry A and B, borrow pit excavated
1962-1976	ADOT&PF	Dozer trail cut between the Lower and Upper Loci, surface of the Lower Locus bladed?
1983	ADOT&PF	184 cubic yards of rip-rap removed
1990	ADOT&PF	500 cubic yards of rip-rap removed
1993	Deltana, Inc.	Emergency – material to rebuild dike, unknown quantity of rip-rap removed
1994-1995	ADOT&PF	18,835+ cubic yards of rip-rap removed, removal of the major portion of the hill at Lower Locus (Quarry A), expanded gravel work pad on floodplain south of the Lower Locus
1999-2000	ADOT&PF	11,339 cubic yards of rip-rap removed, highwall left to southwest of Lower Locus
2000	DMTC	Surface blasted at Quarry A, mine adit excavated, trail excavated into slope between Upper and Lower Loci
2000-2003	DMTC	Continued excavation at mine, shoring up of high wall above the adit and below the Lower Locus
2001	DMTC	Trail excavated into slope between Upper and Lower Loci and highwall to southwest of Lower Locus were sloped and reseeded with grass
2002	ADOT&PF	Massive quarrying on eastern face of the Gerstle River hill

Given fragmentary records obtained from ADOT, it is possible to reconstruct the quarrying activities at the Gerstle River Site over the last forty years. While it is uncertain to what extent the Alaska Highway construction affected the site, it seems probable that only a relatively small portion of the lower hill, at its southwestward extremity was removed prior to the transferal of the property to the State. The 1953 aerial photograph does not show the access road, whereas the 1954 aerial photograph clearly shows the road, which must have been constructed between 1953 and 1954.

Balvin (1962) noted that two areas were quarried up to 1962: (1) Quarry A, described as 50 m long and 5 m high area, and (2) Quarry B, described as 34 m long and from 3 to 12 m high (see Figure 3.9). In addition, a 50 m x 10 m gravel borrow pit was noted to the east of the access road. Importantly, Galvin notes that "[o]verburden consisting of silt and organic material to two feet thick is exposed along the top of the face and probably mantles the slope above the pit area" (Balvin 1962: 1). Therefore, it is likely that the prior work at the site consisted primarily of removal of material from the borrow pit and from the edges of the southwest hill face of Quarry A and from Quarry B. According to the topographic map included in Balvin's report, the quarrying extended to 60 feet (18.3 m) up the Quarry A working face. This matches well with the 1994 ADOT topographic map which shows the hill top above Quarry A as approximately 21 m above the surrounding terrain. Therefore, it is unlikely that the hill top (i.e., bluff edge) extended southward prior to the 1962 transferal of the quarry to ADOT. aerial photographs available from 1953 on to 1976 support the hypothesis that the hill top bedrock was still largely intact, with only the lower face the focus of quarrying activities. The sketch topographic map in Balvin (1962) shows a talus slope below rock outcrops to the east of the Quarry A area. These areas are apparent in the aerial photos for 1953, 1954, and 1961 (Figure 3.9).

No mention is made in Balvin (1962) of a road or cat trail extending from the southwest side of the hill or traversing the hillslope above Quarry A. This dozer trail is apparent from Holmes' 1976 investigation at Gerstle River, and must have been constructed between 1962 and 1976. It was likely that during this period, the Lower Locus surface vegetation was removed and the area was graded, removing an estimated 0.5 m of the uppermost undisturbed sediment.

Given the sketch map in Balvin (1962) and an ADOT map of the material site dated 7/25/1994, apparently little work was done in the intervening years. The 1994 map is identical to a site map in Kimura et al. (1989) showing the 1983 and 1985 work at the Upper Locus. It is unknown which map was derived from the other, as the 1994 map does not have the Upper Locus archaeological area marked. The site photographs and site sketch map by Holmes in 1996 shows that a considerable portion of the hill was removed at some point between the summer of 1994 and the summer of 1996. It was likely that during this process that the overburden (~1 m) was pushed from the hill down to the swale and onto the Lower Locus, and the large boulders tumbled or were pushed downslope. A very crude sketch map from this period (1994-1995) shows an area of 76 m (E-W) by 46 m (N-S) "cleared of trees and most [of the] silt overburden." Figures 3.10-3.11 show the destruction of the southern hill.

In the summer of 1999, at the beginning of this archaeological project, Whit Hicks, D-GSD (later Director of the DMTC) excavated a bench directly below the site in order to ensure safety of the archaeological field crew. Mechanized excavation was overseen by two archaeologists, myself and Charles E. Holmes, in order to minimize damage to the site, to monitor for cultural material, and to observe deposition of the excavated sediment. An excavator was used to remove minimal amounts of material along the bluff edge to create a foundation for the bulldozer that plowed a bench below the bluff edge (Figures 1.16-1.17). Large boulders (2+ m in diameter) were pushed to the north of the Lower Locus area, over the area of the old cat trail. Due to the presence of overburden over the Lower Locus in 1999 prior to excavation (ranging from 0.20 m to 1.23 m based on auguring), the Lower Locus was scraped in ~10 cm levels until most of the overburden was removed. Given observations over the past four years of research, overburden depth ranged from 0.10-0.50 m.

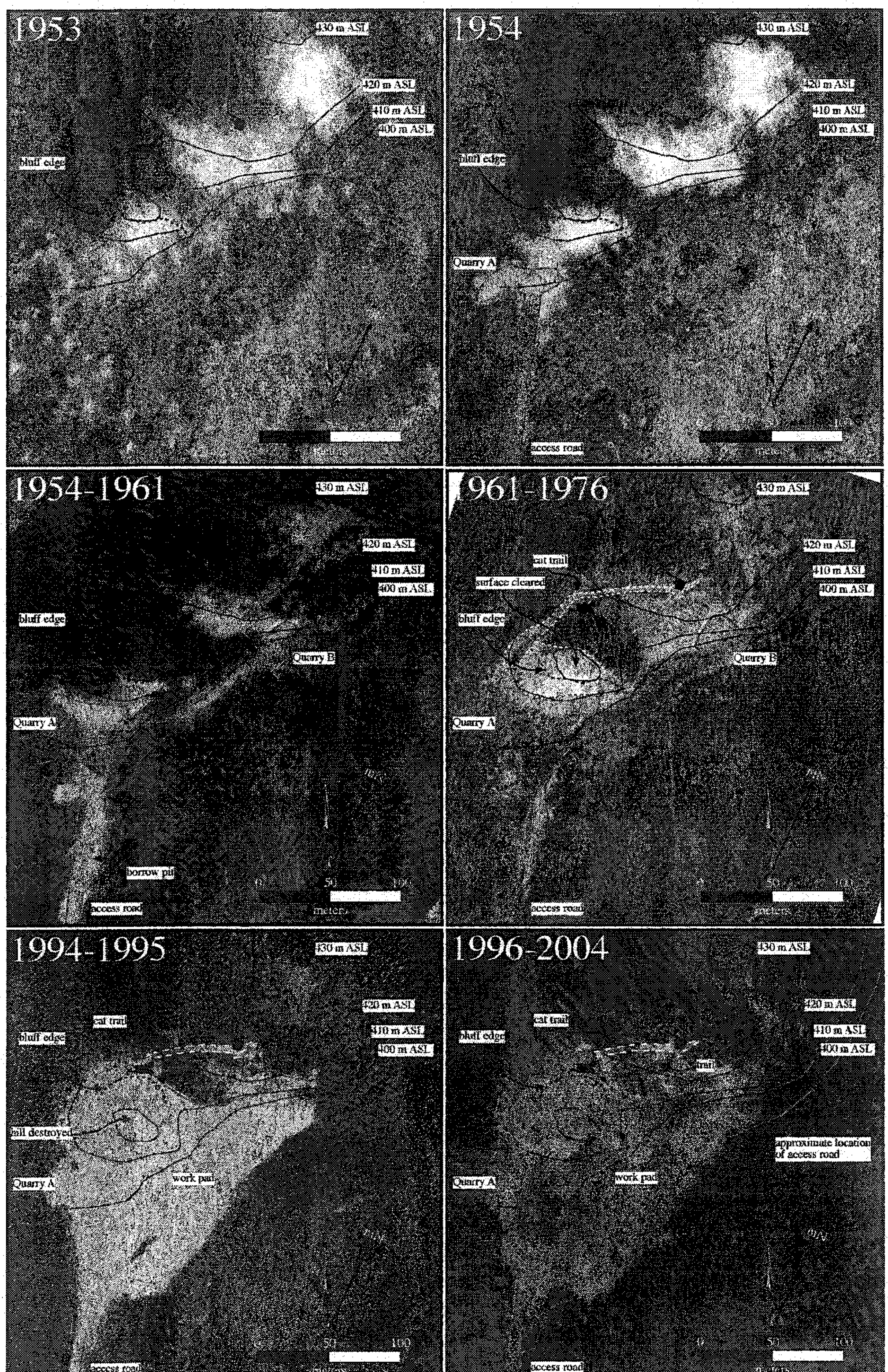

Figure 3.9. History of disturbance at Gerstle River.

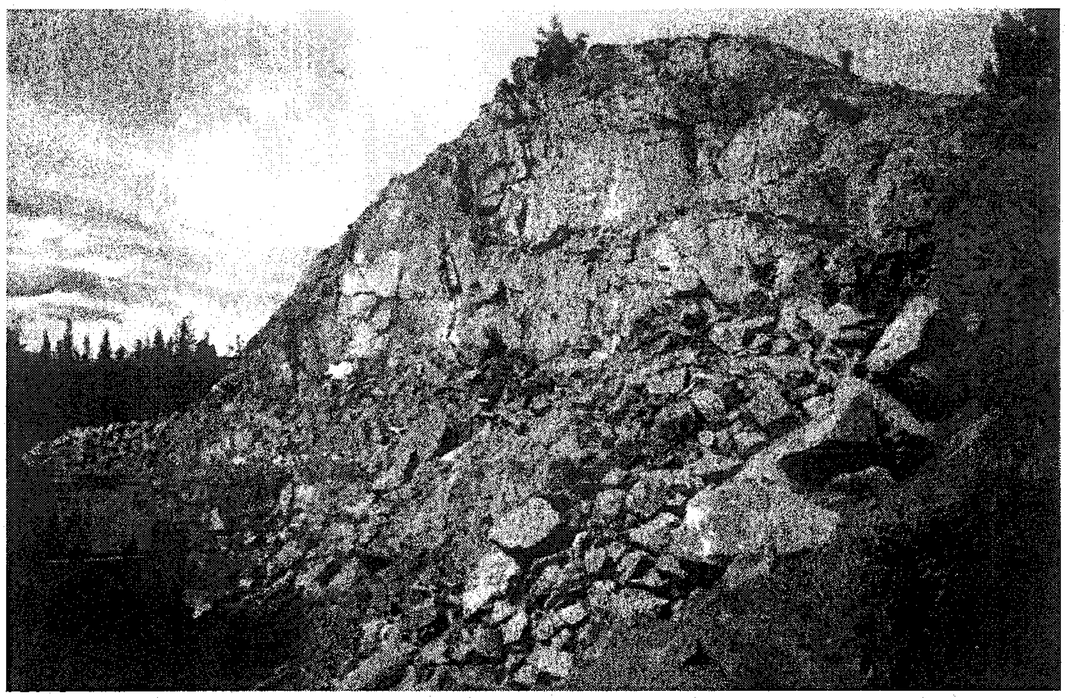

Figure 3.10 Destruction of the southern hill, view west, 6/21/1994 (ADOT&PF photograph). The extant Lower Locus archaeological site is located to the right of the person on the hill crest.

Figure 3.11 Loading charges on top of the southern hill, view southwest, 6/21/1994 (ADOT&PF photograph). Note the thick silt loess deposit on the southern hill.

In the fall of 1999, the DMTC blasted an adit directly below the site, and continued to work to lengthen the tunnel from 2000 to present (2003). Material from this work has been piled up against the high wall (bluff edge) directly above the adit and below the Lower Locus. In winter of 1999 and spring of 2000, ADOT excavated much of the remaining rip-rap to the southwest of the Lower Locus, leaving a highwall to the west. No artifacts or cultural remains were noted in this area after this work. This highwall was sloped by DMTC in 2001. In the summer of 2002, ADOT&PF excavated rip-rap from a new quarry on the eastern face of the hill, well distant from both Gerstle River Loci. No other disturbance occurred after 2002. Figures 3.12 and 3.13 illustrate the evolution of the southern hill face and the Lower Locus of the Gerstle River site between 1983 and 2004.

Reconstruction of Site Area

Given the aerial photographs, the 1962 and 1994 topographic maps from ADOT&PF, and various photographs prior to 1995, it is possible to reconstruct the topography and vegetation of the Lower Locus area. The Lower Locus was situated on a saddle between a low hill projection to the south and a larger hill to the north (Figure 3.14). The hill, designated as *southern hill*, measured approximately 75 m N-S, and 90 m E-W. The base of the Southern Hill was probably around 400 m ASL, and the top of the hill was around 421 m ASL. A talus slope was present at the southern end of the southern hill, and rock outcrops were present at the southeastern face, similar to the Quarry B face to the east (see Figure 3.13).

The Upper and Lower Loci of the site were located in closed white spruce forests. Treeless areas vegetated with xeric flora like Artemisia were located on the south facing slopes of the southern hill and the main hill (Figure 3.14). The Lower Locus was about 50 meters north and back from the bluff edge of the southern hill. This southern edge was characterized with rock outcrops on the southeastern side and a talus slope on the southern side (similar to the natural slope of the hill one mile east of the main hill). The southwestern slope of the southern hill appears to have been gradual and was covered with white spruce forest. Access to the Lower Locus could have been made from the southwest or the southeast, though the former appears to have been a more gradual slope. The top of the southern hill would have made an excellent observation point with a view in almost 270° from NNW to ENE. The Lower Locus was partially sheltered from the elements with the presence of the southern hill to the south. Figure

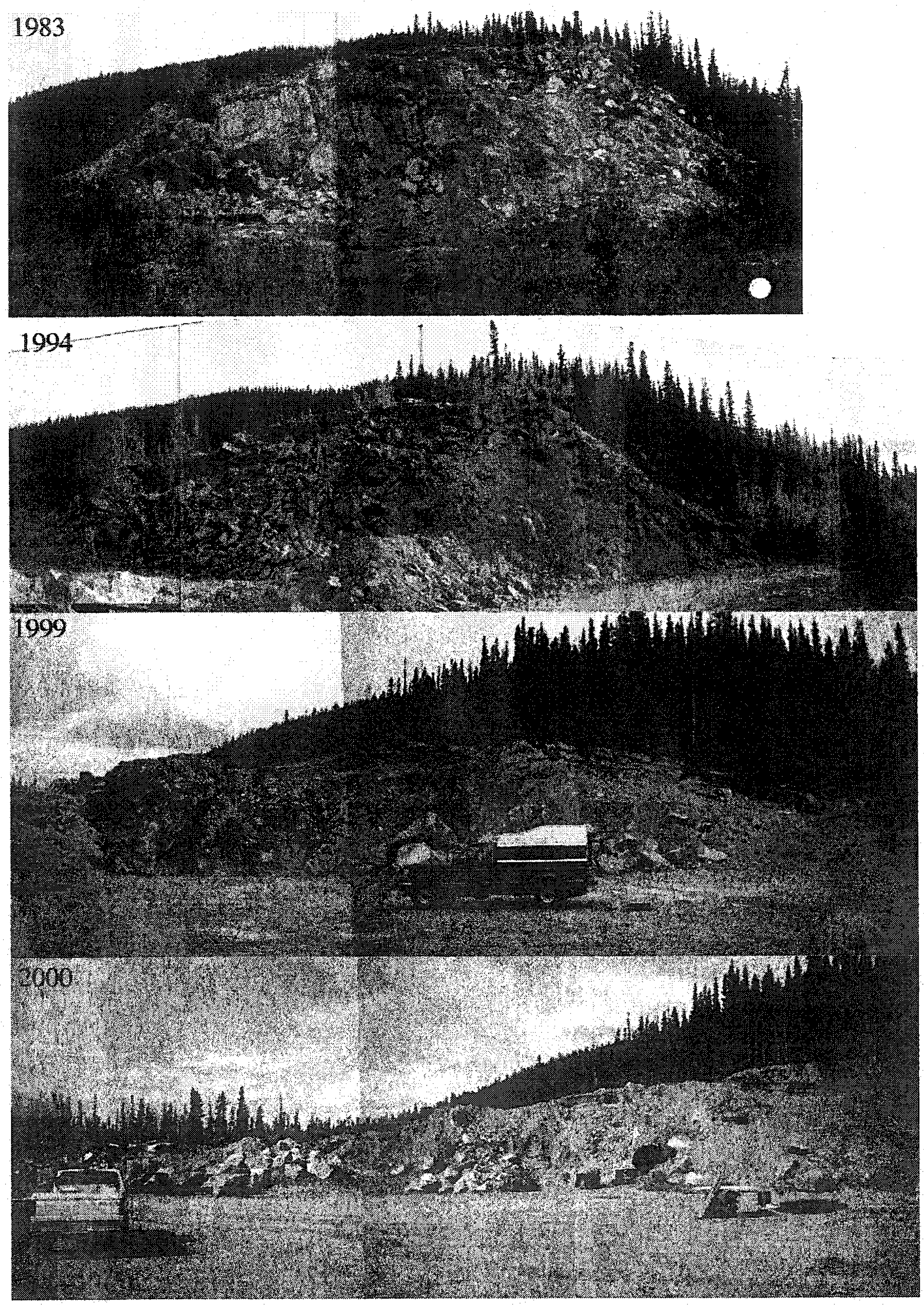

Figure 3.12 Gerstle River Lower Locus, view north in 1983, 1994, 1999, and 2000.

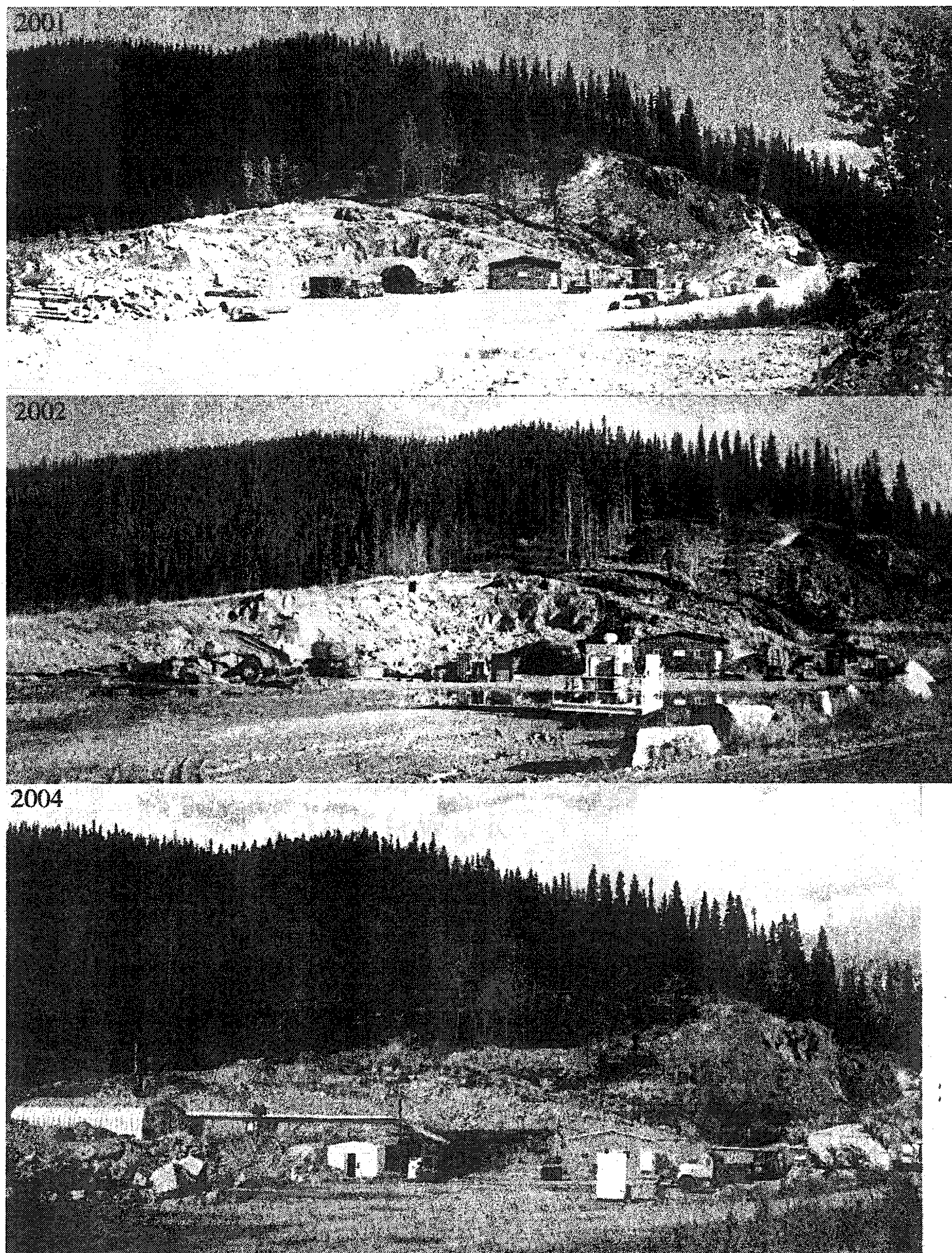

Figure 3.13 Gerstle River Lower Locus, view north in 2001, 2002, and 2004.

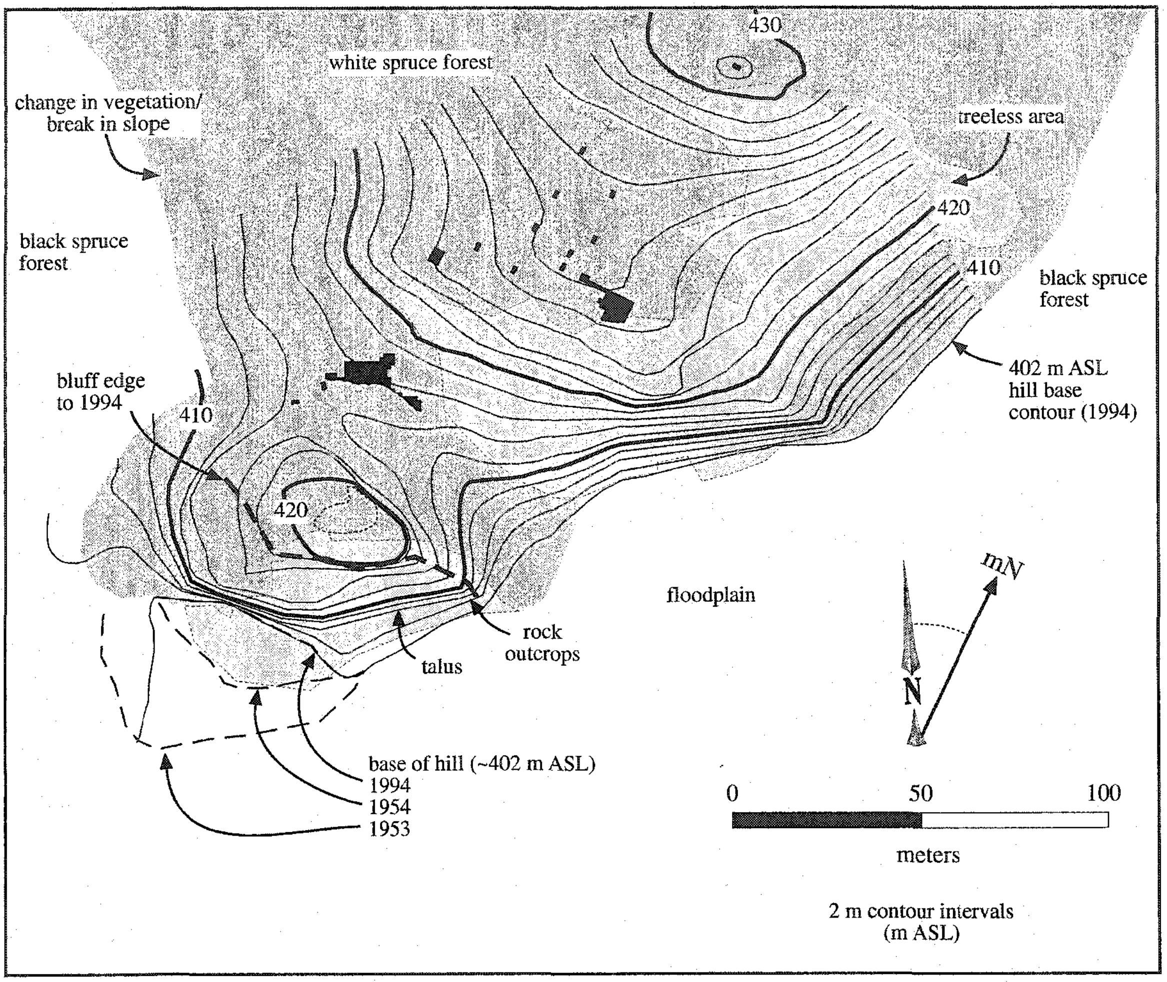

Figure 3.14 Gerstle River reconstruction.

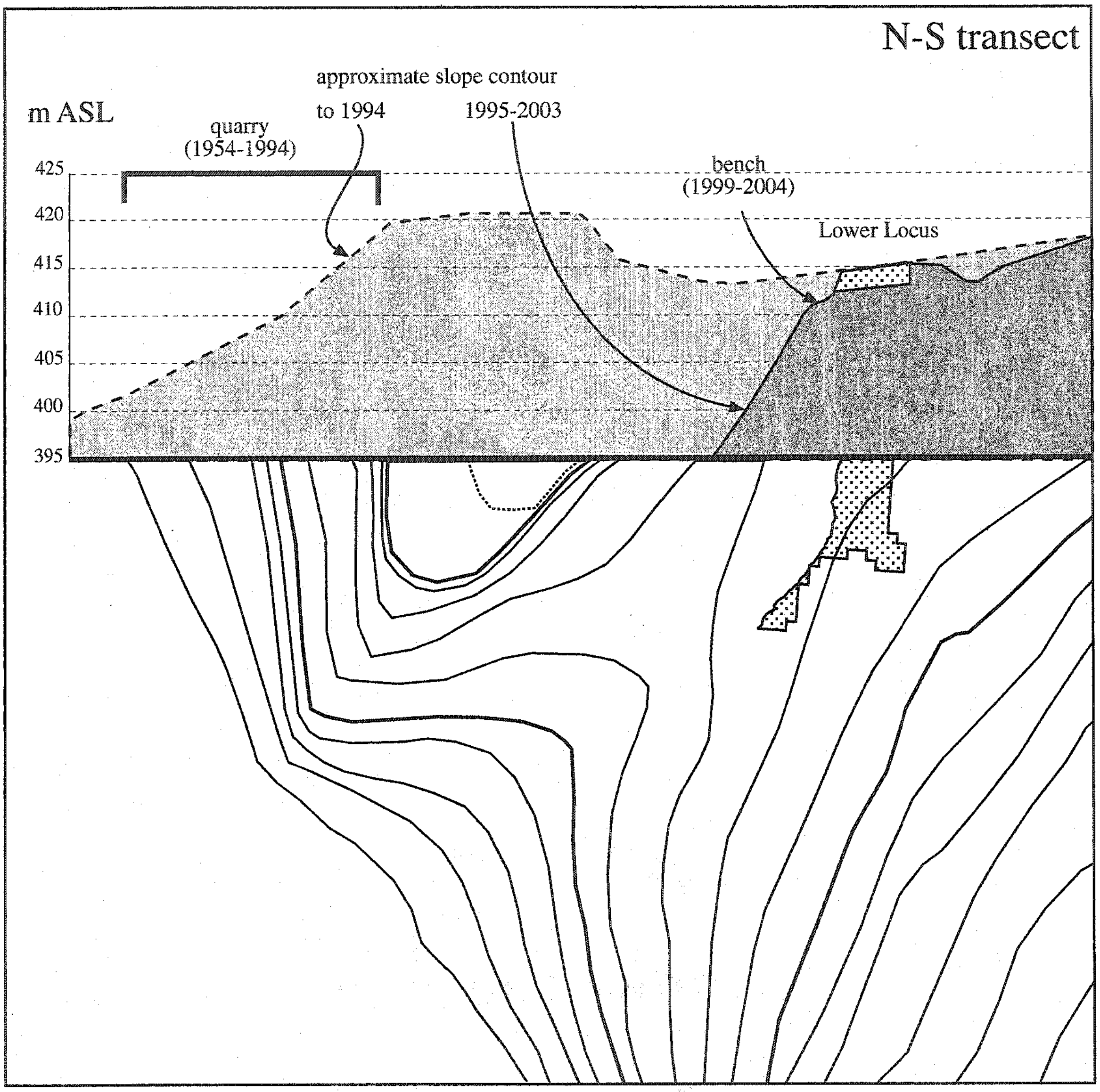

Figure 3.15 Gerstle River hill cross-section.

3.15 shows the slope along a north-south transect. This could have made it suitable for a wider range of activities, and would have at least enabled occupants to be sheltered from view on the floodplain below the site.

We will never know about the relationships between the Lower Locus itself and any archaeology that would have been present on the southern hill due to the destruction of the site by ADOT&PF in 1994-1995. The fact that artifacts and faunal remains were eroding as early as 1976 and perhaps 1962 suggests that the entire southern hill was occupied by at least one component.

The archaeological site areas for the Upper and Lower Loci were estimated using ArcView (Table 3.8, Figures 3.16-3.17). The Upper Locus site area estimate is based on topography and artifacts recovered in 1985 and 1996. The Lower Locus estimation is based on topography and the location of eroding cultural materials. The destruction of the southern hill has resulted in the loss of about 83% of the Lower Locus, of which only about 590 m^2 remains. Given the current excavation totals (1976-2003), only 3% of the Lower Locus has been excavated and 5% of the Upper Locus has been excavated. Using the post-1999 Lower Locus area estimate, about 62% of the Lower Locus remains for future excavations.

Table 3.8 Site area estimates.

Area	*est. total site area (1953)*	*est. total site area (1999)*	*excavated area*	*est. site area remaining*	*% excavated (of 1999 area)*
Upper Locus	1,760 m^2	1,760 m^2	96 m^2	1,660 m^2	5%
Lower Locus	3,490 m^2	590 m^2	111 m^2	480 m^2	18% (3% of 1953 area)
Total Site	5,250 m^2	2,350 m^2	207 m^2	2,140 m^2	9%

Note: estimated areas are rounded to the nearest 10 m^2.

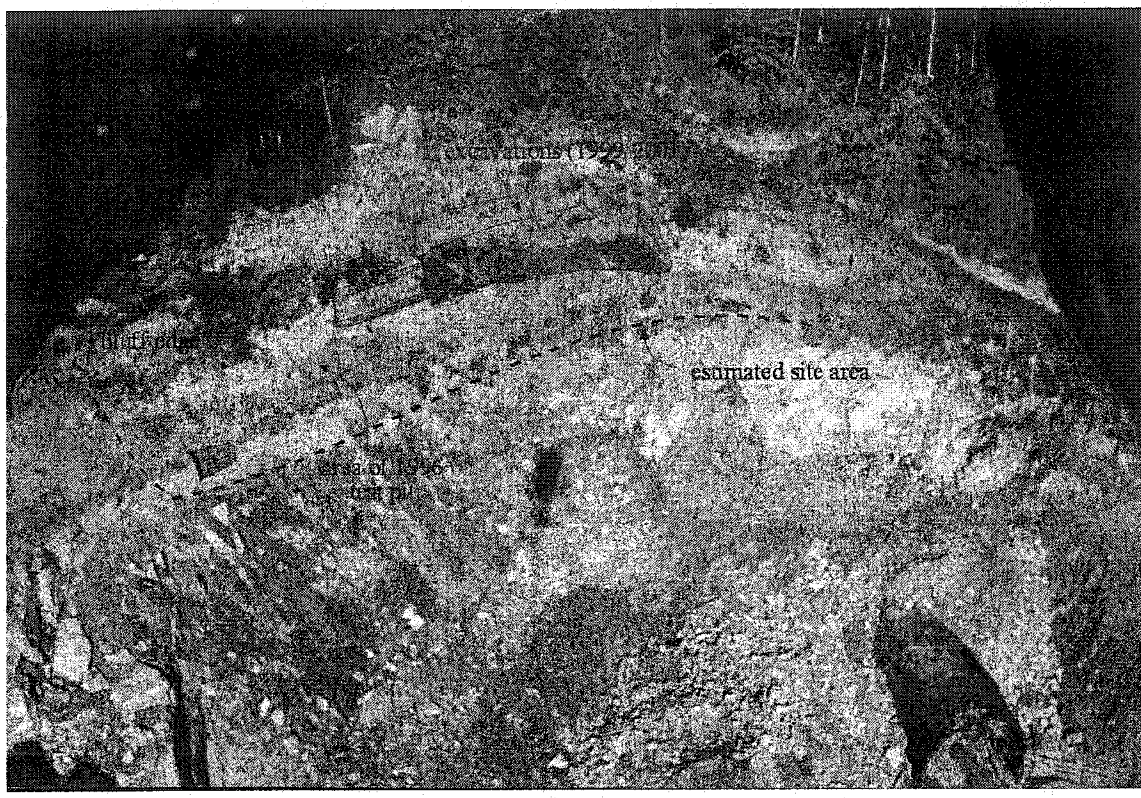

Figure 3.16 Estimated Lower Locus site area.

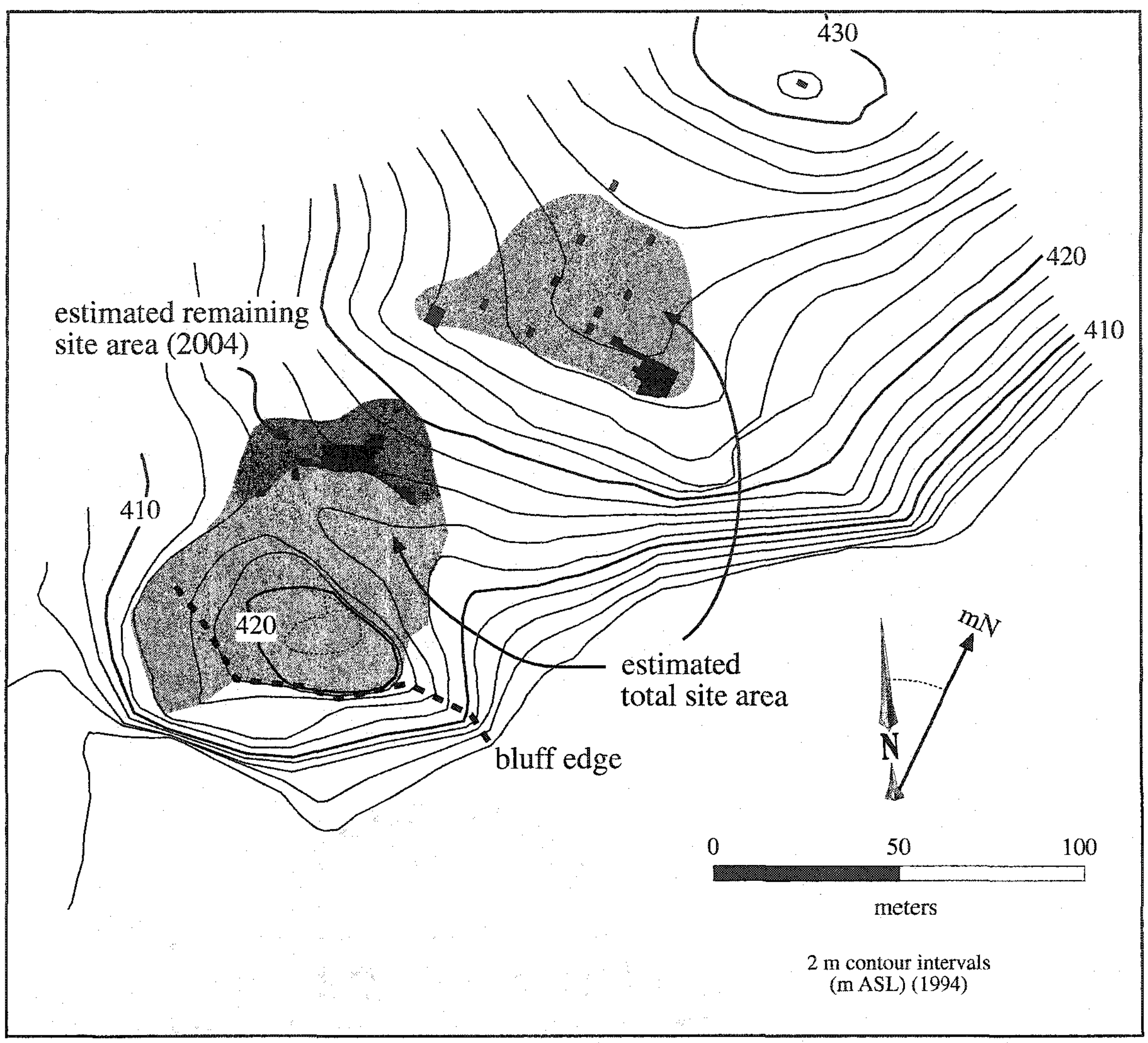

Figure 3.17 Site area estimates.

CHAPTER 4. STRATIGRAPHY AND SEDIMENTS

Introduction

Situating cultural occupations at Gerstle River within their appropriate environmental contexts requires a careful description and exploration of the stratigraphic record, especially with respect to loess deposition, paleosol formation, and the integration of chronological controls. This chapter examines the stratigraphy and sediments at the Gerstle River Lower Locus in order to address a number of specific research objectives.

The primary objectives of the sediment and stratigraphic analyses at Gerstle River are to (1) document Lower Locus stratigraphy and identify lateral variations across the site, (2) integrate the radiocarbon dating, stratigraphy, and cultural components in order to relatively and absolutely date the geologic and archaeological events at the site, (3) assess the degree of disturbance within cultural-bearing layers, and (4) reconstruct the paleoenvironmental history at the site. Correlation of the Upper and Lower Loci strata and archaeological components is presented in Appendix B.

These research problems are addressed in a variety of ways. Emphasis was given to accurately delineating stratigraphic units across the site and identifying lateral limits in these units. Another focus was on assessing the spatial locations of cultural features, artifacts, and faunal remains with respect to these stratigraphic units. Understanding site formation processes are thus key to assessing the potential integrity of the cultural components. The degree of spatial integrity is critically important when developing and testing hypotheses about cultural site formation at high resolution (see Chapters 5-10).

The regional bedrock geology and glacial geology has been described in Chapter 3, and salient points are briefly summarized here. The Gerstle River site lies on a bedrock knob of Mesozoic age granodiorite (Hamilton 1973; USGS 1954; Balvin 1962; Brazo 1977; Solie 1999; Ferrians 1965). Glacial moraines are present about 4 km south of the site. Surface deposits are characterized as unconsolidated quaternary deposits, largely the result of stream and lake alluvial deposits and outwash gravel. The active Gerstle River channel is located about 1 km west of the site. Permafrost is discontinuous in the region, and was not encountered at the Lower Locus. The soils at the Gerstle River site are characterized as *Typic Eutrocryepts, bedrock substratum, 30-60°*

slopes, and are typically found on shoulders and south-facing slopes of bedrock uplands (Swanson 2002: 40-41). The sediments at the site consist of aeolian loess and sand units overlying weathered bedrock.

This chapter is divided into a number of sections. Detailed stratigraphic profiles (Figures 4.2-4.5), composite profile (Figure 4.1), results of granulometric and loss on ignition analysis (Figure 4.6), fence diagrams (Figures 4.7-4.9), and photographs (Figures 4.10-4.16) are used to describe the stratigraphy and sediments at the Lower Locus. Specific results of granulometric analyses are presented. Variation in stratigraphy and deposits within the Lower Locus are examined. Sediment deposition/accumulation rates and variability within the Lower Locus and between the loci are discussed. Stratum thickness variability and microtopography at the Lower Locus is described.

Post-depositional disturbances are examined and various data are used to evaluate the spatial integrity of all archaeological components at the Lower Locus. Profile back plots are used to assess spatial disturbances at high resolution. A provisional model of site formation is provided, with the caveat that more detailed geological work needs to be conducted in order to fully validate the depositional history model presented here.

Methods

Given the objectives described above, a number of field and laboratory procedures were implemented to address these questions. A detailed, comprehensive analysis of the sedimentology at the site is beyond the scope of this project. Sediment descriptions generally follow Dilley (1998:278) for sediments above Unit VI, but the presence of more complex stratigraphy below this unit necessitated more detailed investigation. Stratigraphic profile and sediment sampling methods are described below. Other analyses, such as grain surface morphological analysis, soil pH, pipette analysis for clay content, chemical analyses, and other geoarchaeological analyses could be incorporated in future research at Gerstle River in order to more fully explore the sedimentary history.

Field Methods

For field identification, the massive aeolian silt was termed Y1-Y5, and the Bw horizons were termed R1-R5 (red versus mottled yellow loess). From the beginning, an objective of the excavation was to maintain stratigraphic control across the site and enable stratigraphic correlations among various paleosols among the Lower Locus excavation areas and the Upper Locus. To this end, I excavated in 2 x 2 m blocks with a stratigraphic profile generally for each two meter section, resulting in a stratigraphic grid across the site (see Figures 4.2-4.5, 4.7-4.9). Excavations were conducted by natural strata from the surface to the R4/Y4 interface where 10 cm levels were excavated given the discontinuity of R5 and the lack of differentiation in the massive loess (Y4a, Y4b). Buried surface contours were noted, drawn, and patchiness was documented.

Stratigraphic profiles were mapped at generally 1:10 scale with the aid of a line level. Ninety-five linear meters of stratigraphic profiles were drawn for the Lower Locus, including 20 linear meters drawn for the lower sediments (Units I-VIIb). I employed stylized section drawings, with interfacial lines and labeled layers (Wheeler 1954; Harris 1979:58). Two types of units were drawn, allostratigraphic units such as bedded sand (Unit VII), and upper loess (Unit IX), and pedostratigraphic units such as strata R4, R3a, and P1. Allostratigraphic units were identified by their boundaries (discontinuities) where pedostratigraphic units consisted of pedologic horizons within allostratigraphic units. Other features like charcoal stringers, artifacts within ~2 cm of the mapped wall, krotovinas, and microfaults were mapped as well. Photographs were taken for each exposed wall for each year of the investigation. Large stretches of profiles were sought in order to evaluate the spatial integrity of the components, and to trace pedogenic units across the site to assess relative chronologies. This was necessary, for instance, to determine the stratigraphic location of Component 5 within Block Y located 24 m away from the dated R3a horizon which brackets the occupation. The profiles were scanned and translated to vector graphics for use in presentation and construction of fence diagrams (Figures 4.2, 4.7-4.9). Fence diagrams are integrated three-dimensional representations of site stratigraphy based on stratigraphic profiles. For Figures 4.7-4.9, a horizontal control line at 1.0 m below site datum was used.

Sediments were described following Soil Survey Division Staff (1993) and Dilley (1998), including data on soil texture, mottling (redoximorphic features), and grade. Horizon descriptions include boundary distinctness and topography, organic matter, color (Munsell), mottling, and texture.

A total of 87 sediment samples were collected from the Gerstle River Lower Locus as part of the 1999-2003 investigation. Two types of collection strategies were implemented. The first involved collection during excavation, including discolored matrix, stains, tephra, and other sediments for which future analysis might be warranted. These included 48 samples of stains, charcoal rich layers (R5), tephra samples, and a pebble layer (Feature 6, see below). The second collection strategy was extraction of sediment samples from cleaned walls after excavation in 1999 and 2003. The purpose of retrieval from excavated walls was to allow suitable provenience controls by means of specifying exactly where each sample derived on the stratigraphic profiles. A total of 39 samples of all observable stratigraphic units were collected in this fashion. Using a clean trowel, about 500 g of each sample was removed and placed in archival plastic bags.

Loss on Ignition (LOI) Analysis

A hand sample splitter was used to produce 10 g samples from the samples collected in the field. Each sample was placed in a crucible, weighed to the nearest ten-thousandth of a gram with a Mettler AJ100 scale and placed in a VWR Model 1305 U Utility Oven. All samples were heated to 100° C for one hour and subsequently allowed to cool and weighed. The difference in weight represented the H_20 content of each sample. Each sample was then heated to 500° C for one hour and subsequently allowed to cool and weighed. The difference in weight represented the organic content of each sample. Each sample was finally heated to 850° C for one hour, allowed to cool and weighed. The difference in weight represented the carbonate content for each sample.

Granulometric Analysis

Granulometric analysis was conducted on 26 samples collected in 1999 for all primary stratigraphic layers at the site. Using the hand sampling method, the sediment samples were split into 100 g samples for granulometric analysis. Macroscopic organic material (charcoal flecks, etc.) was removed from each sample as this could affect phi size determination. The results of the LOI analysis indicated that organic weights (combined carbon and carbonate fractions) averaged 6.2±2.5 percent for all of the samples. Thus, for the preliminary granulometric analyses presented here, microscopic organics were not chemically removed. Each 100 g sample was weighed to within 0.1 g minus the weight of the container, and then run through six sieves: U.S. sieve mesh 6, 20, 40, 60, 100, and 230. The samples were mechanically agitated for 20 minutes. Weights of the material collected in each sieve as well as the bottom were made to within 0.1 g and the values were recorded. Given time limitations, the hydrometer method was not used to separate silt and clay, and the results given below are for a combined silt/clay fraction.

Ground Surface Estimation

Given the absence of upper strata at the Lower Locus, a general stratigraphic profile was developed for surface to stratum R2 based on the upper strata at the Upper Site and correlations with the Lower Locus. In general, the Lower Locus received almost twice as much deposition by depth as the Upper Locus in the same time period (10000 BP - present), suggesting that the upper strata may not have been deposited at the same rate. Using the profile at N49E44 (Block Q) and the profile at N10W11 (Block A), the strata were aligned at the top of stratum R4. Holding this position constant, strata R3, Y2, and the top of R1 were generally the same relative depth. This procedure yielded surface estimates for N49E44: surface 58-65 cm BD (below site datum), tephra 65-69 cm BD, A horizon 69-75 cm BD, B horizon (R1) 75-80 cm BD, stratum Y1 at 80-90 cm BD, stratum R2 at 90-103 cm BD, and stratum Y2 from 103 cm BD to its observed boundary with stratum R3 at 115 cm BD.

Lower Locus Stratigraphy

There are nine lithostratigraphic units present at the site, Units I is weathered frost-shattered granitic bedrock, Units II-V are C horizons derived from degrading bedrock and colluvial slope wash, Units VI and VIII are aeolian sand deposits, and Units VII and IX are aeolian silt loess deposits including the modern cryochrept soil horizon. Within Units VII and IX are several paleosols consisting of Abk and Bwb horizons. A general stratigraphic profile and radiocarbon chronology for the Lower Locus is illustrated in Figure 4.1. Stratigraphic profiles are illustrated for the main area (Figures 4.3-4.4) and for the northeastern and southeastern areas (Figure 4.5). The results of loss on ignition and granulometric analyses are illustrated in Figure 4.6.

Units I-II, weathered and degrading bedrock

The lowest unit (Unit I) is weathered granodiorite bedrock, exposed at the surface of the quarry south of the Lower Locus, and on the bluff edge below the Upper Locus (see Figure 3.13). Depth to bedrock varies at the Lower Locus and is difficult to estimate given the destruction of the upper strata, but it was located about 410 cm below surface in the main excavation area (see Figures 4.3-4.4, 4.9, 4.14-4.15). The bedrock is weathered and grayish brown in color (10YR 5/2) and oxidized in places to an orangish color. Angular fragments ranging in size from granule to cobble sizes are present at the contact of bedrock and the overlying degrading bedrock layer. These fragments are not polished or ventifacted. The bedrock surface is not smooth, and there are numerous cracks through which overlying sands (Units III and IV) have infiltrated. Decomposing or degrading bedrock (Unit II) is located in these cracks (ranging in size 5-50 cm wide). This material is composed of a very coarse grayish brown sand (median ϕ is -0.5), and ranges in thickness between 5-40 cm. Small clasts, 2-12 mm diameter, make up 21% of this unit by weight. On two profiles, a very coarse brown sand (Unit IIa) is present overlying the degrading bedrock, about 30 cm thick.

Units III-V, grus and colluvial sands

Overlying the bedrock is a related series of olive gray sand (grus) (Units III-V, designated Sands 1, 2, and 3) (10YR 6/2), between 320-390 cm below surface (Figures 4.14-4.15). Units III and V are very similar, both with unimodal distributions around a median ϕ size of 2.0 and 2.1 respectively (see Figure 4.17), identical color (5Y 5/1, olive gray), and similar sorting, skewness, and kurtosis values. Unit IV is the most divergent of the three units with bimodal distribution with high percentages of gravel and very fine sand. Pebble and cobble-sized ventifacts were present throughout Unit IV, but were absent in both Units III and V (Figures 4.7 and 4.8). Krotovinas were observed in Units IV and V, extending into Unit VIa (Figure 4.9). Unit IV was the most poorly sorted at the site, $\sigma_I = 1.65$, whereas the sorting for Units III and V were similar (0.90, 1.00). Unit IV was strongly skewed towards coarse particles (Sk_I=3.52), whereas Units III and V exhibited symmetrical distributions. Unit IV is very leptokurtic (excessively peaked) where Units III and V are somewhat less peaked. Unit IV also has a bimodal particle size distribution suggesting retransport of this layer (see Figures 4.10-4.11). Unit III overlies Unit II in most excavation units, however in EUN49E44, Unit III appears to have infiltrated deep into the bedrock cracks where Unit II may be deformed by cryoturbation. The boundaries between Units II, III, IV, and V are all abrupt and smooth. Given the slope at the Lower Locus, about 8° with a southwest aspect, the presence of ventifacts distributed throughout Unit IV, the lack of ventifacts on any unconformity (e.g., at the boundary contacts of Units III/IV or IV/V), a possible explanation for these layers is an extensive colluvial wash event. The former parent material is hypothesized to be the granodiorite bedrock given the grain sizes, angularity, and color, and these layers are interpreted to be grus from bedrock decomposition at the Lower Locus and perhaps from further upslope.

Only one radiocarbon date has been obtained on materials within these three units, a mammalian bone fragment (0.2 g) within Unit IV about 10 cm above weathered bedrock (Unit I) dating to 11980±120 BP (see Chapter 5). No artifacts or charcoal were located in any of these layers, but another small bone fragment was recovered in 2003 in this stratum. The dated bone may have been redeposited from upslope during the colluvial event(s). It may have been deposited after Unit IV deposition and before Unit V sand accumulation. It may have been deposited within the Unit V sand and mixed with Unit IV sediments. It also may have been mixed into Unit IV stratum from below (Unit III). However, the boundaries of Unit IV are clear with little gradation with the sediments above or below. Both bone specimens are clearly associated with ventifacts from Unit IV. Therefore, the second and last hypotheses do not appear to be supported. The first and third cannot be refuted based on the present evidence. Therefore, this date may be associated with this stratum as a *terminus ante quem*, that is, a lower limiting date for Unit V.

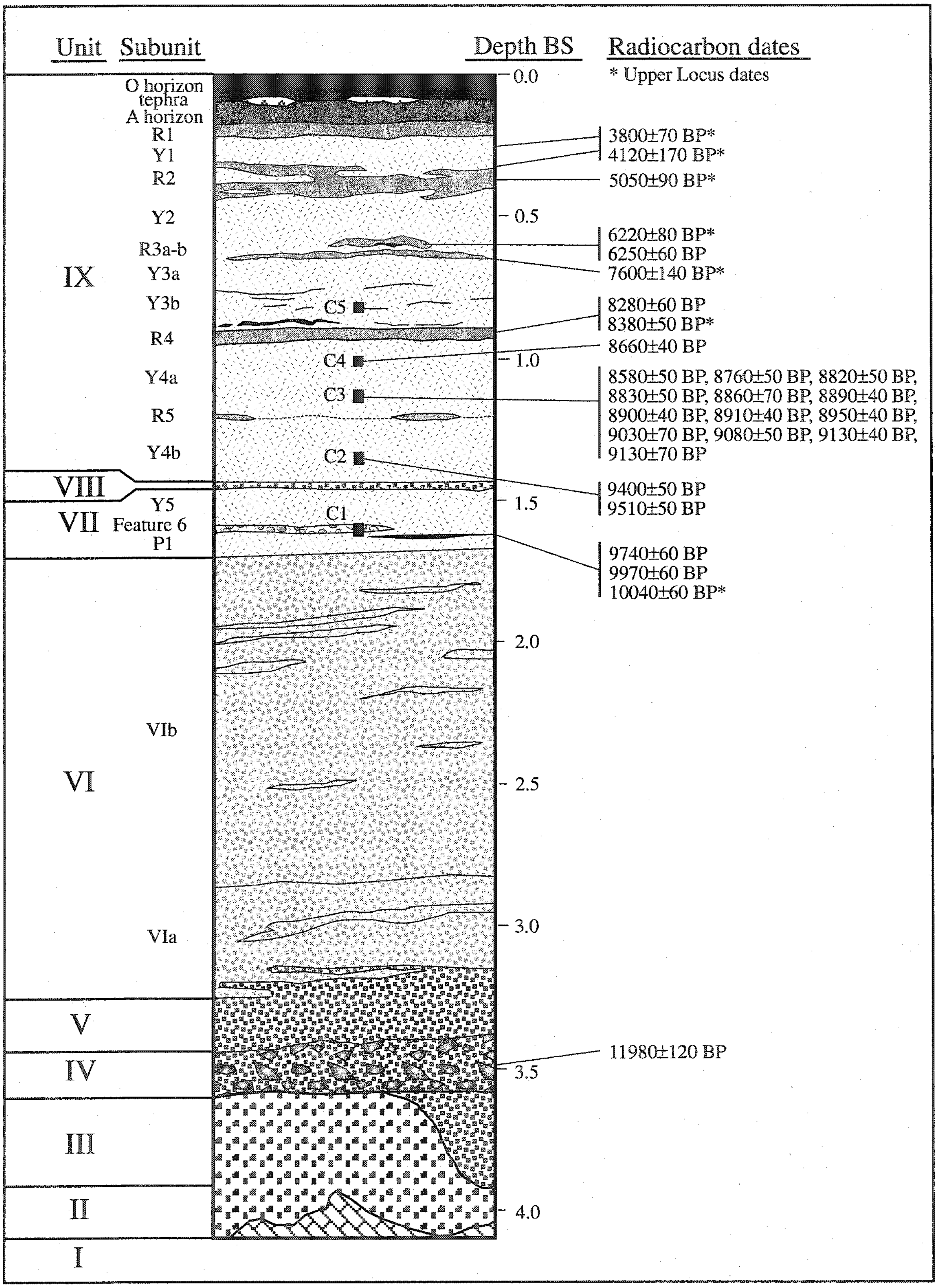

Figure 4.1 General stratigraphic profile, Lower Locus.

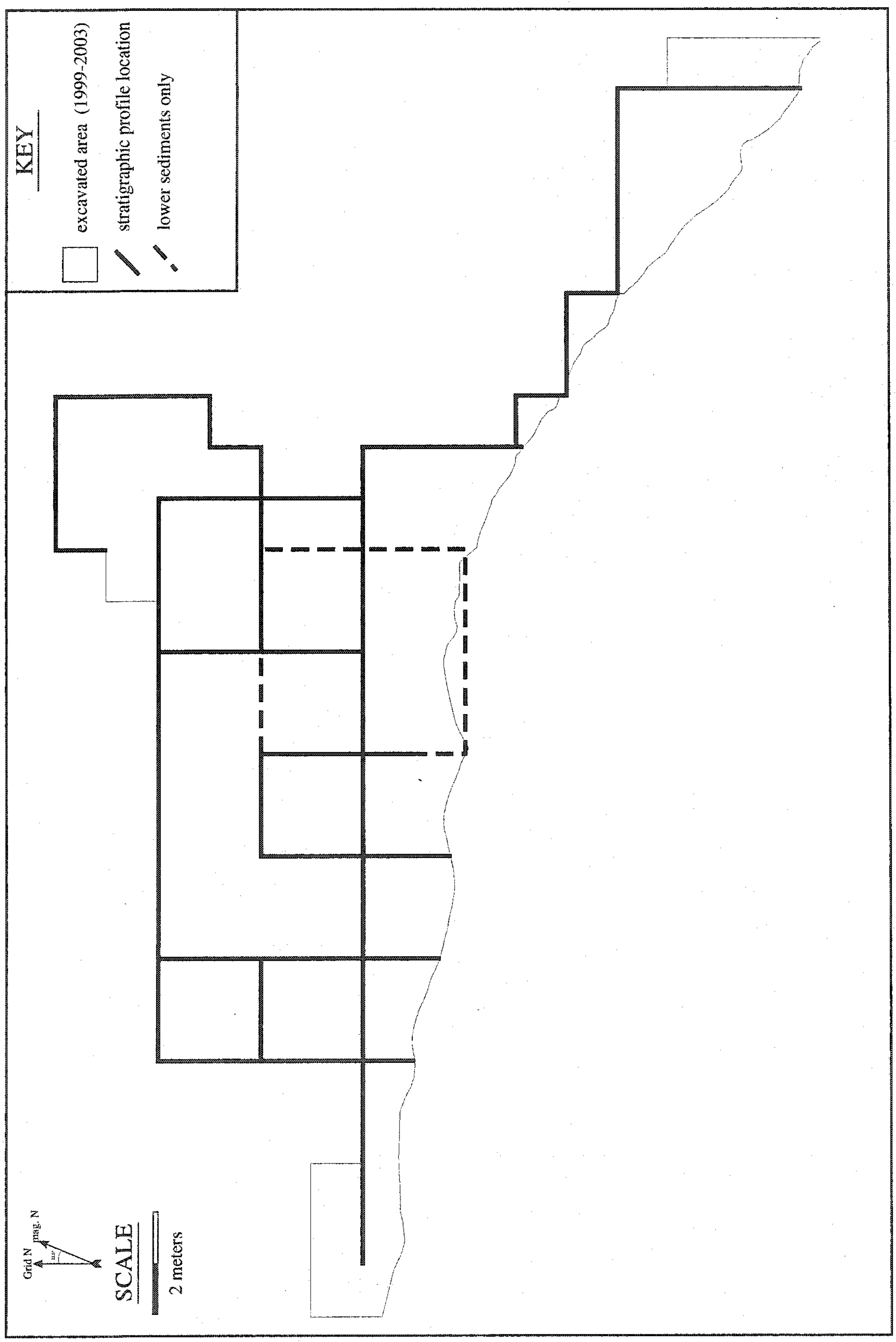

Figure 4.2 Locations of stratigraphic profiles.

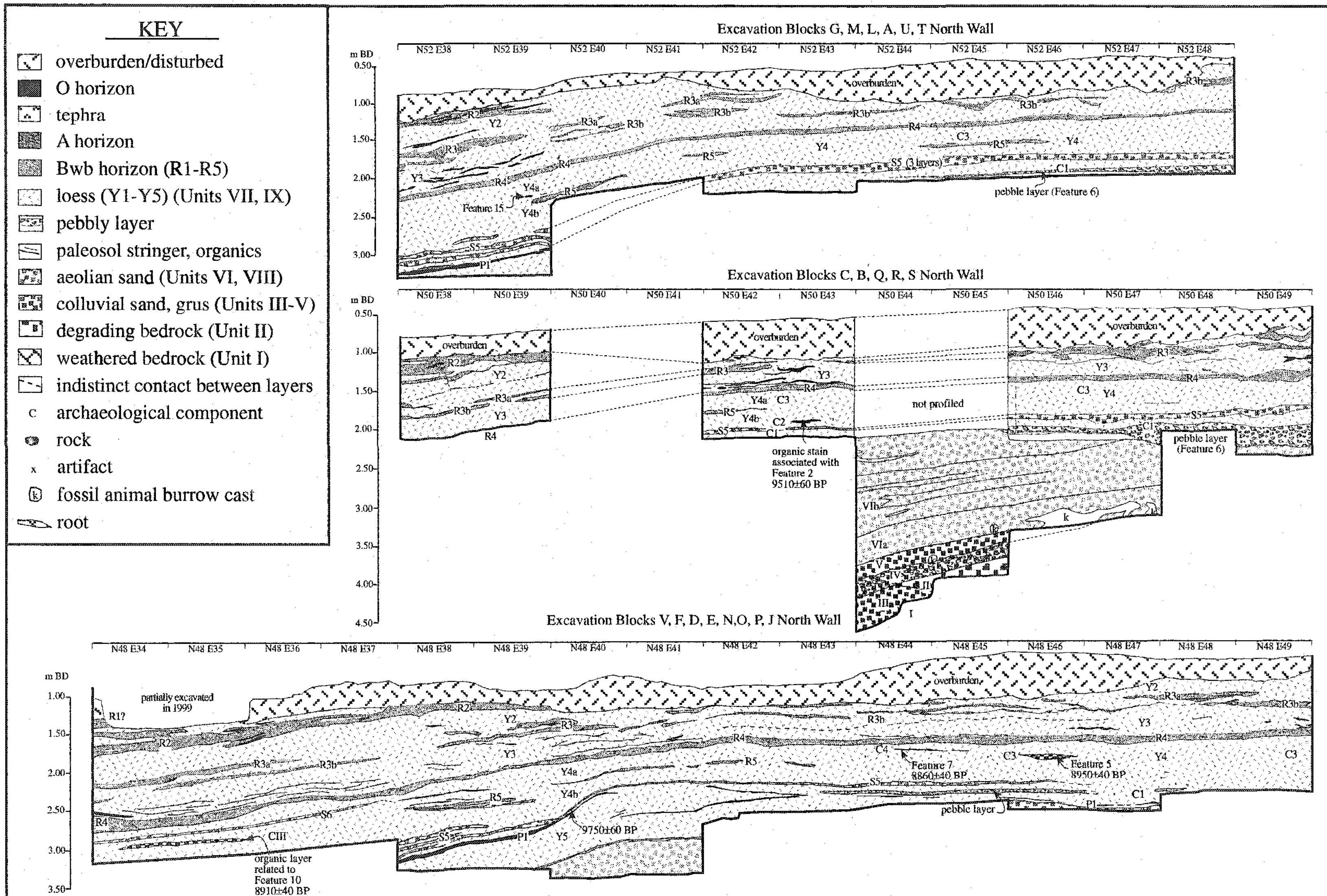

Figure 4.3 East-west stratigraphic profiles of the main excavation area.

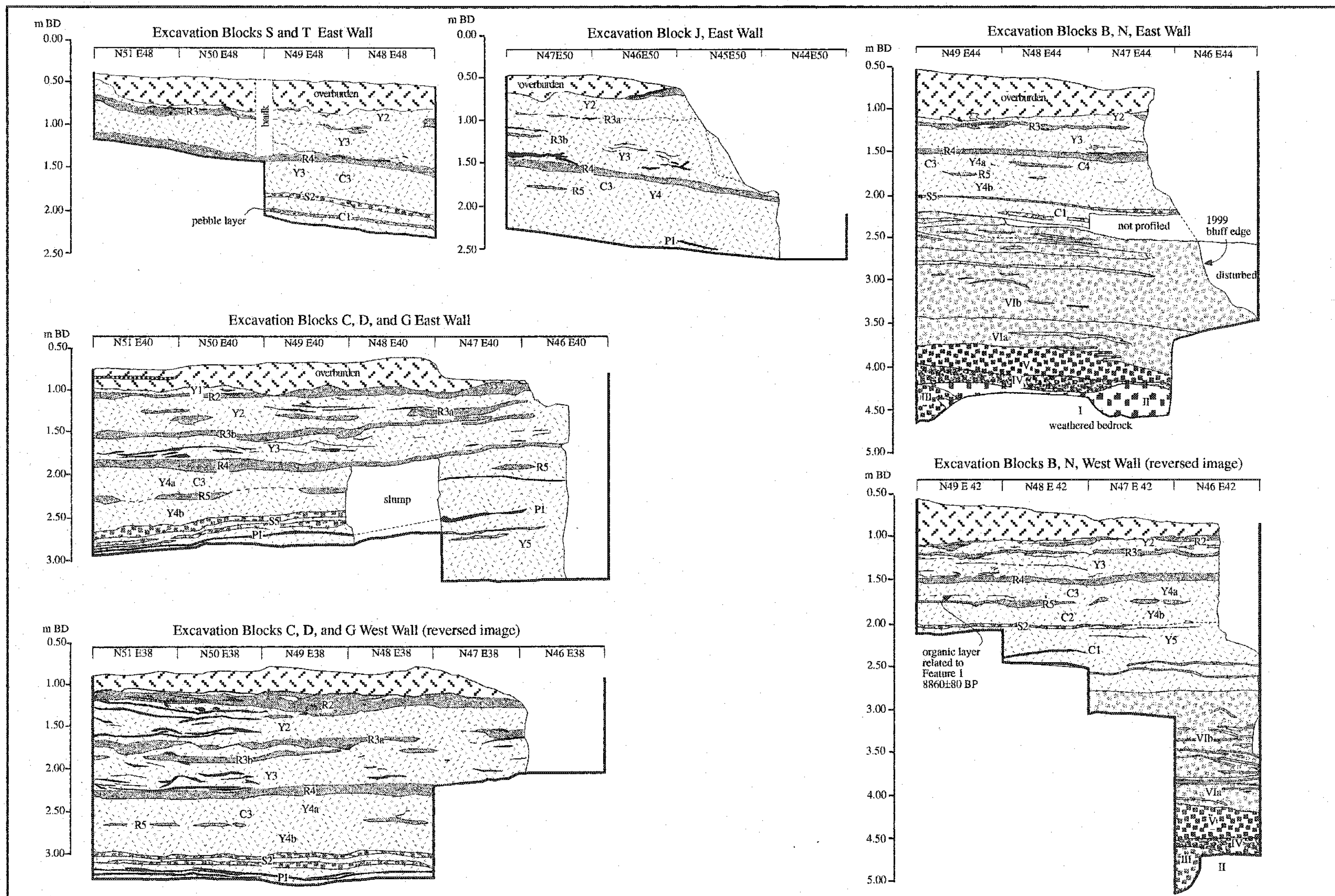

Figure 4.4 North-south stratigraphic profiles for the main excavation area.

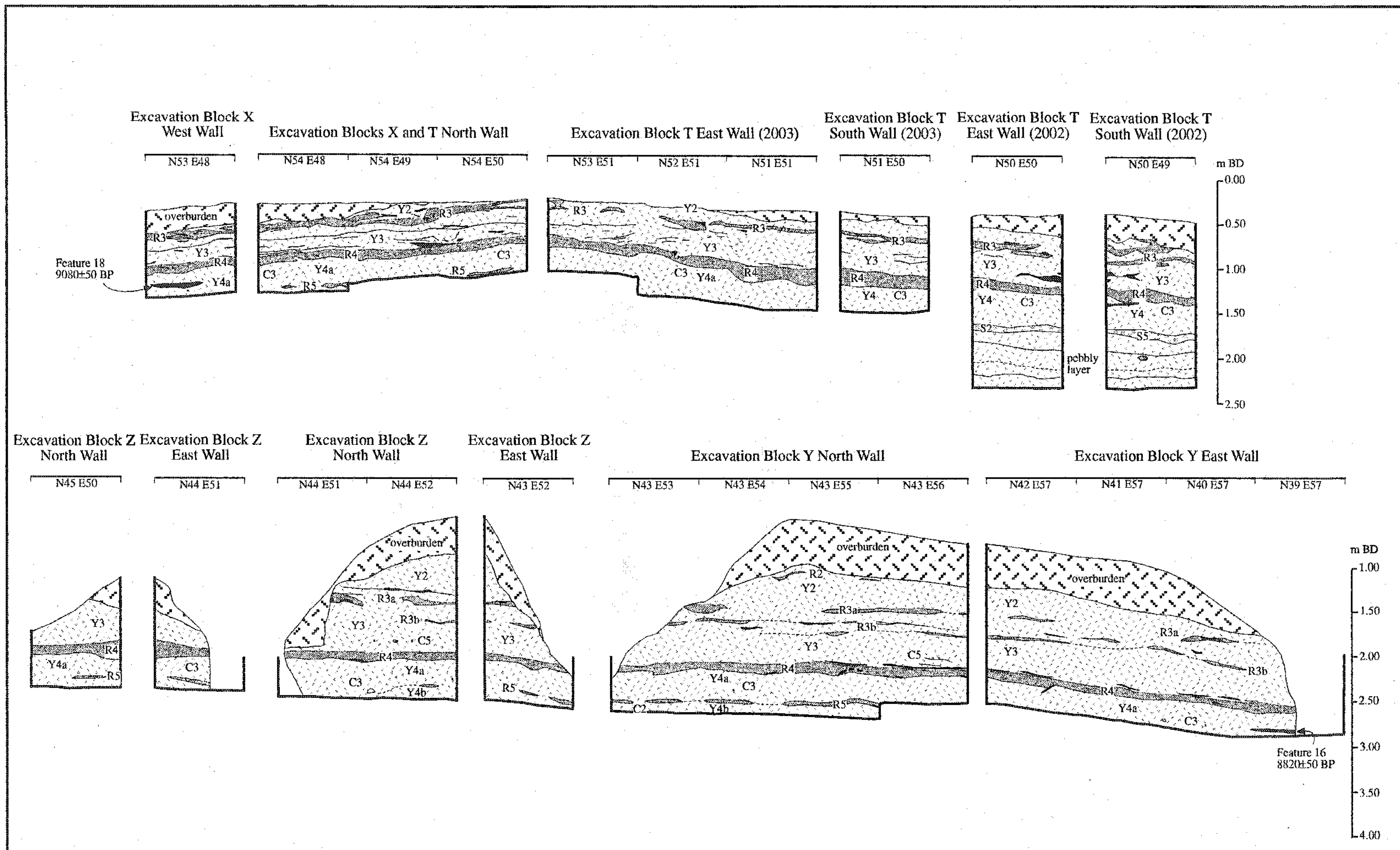

Figure 4.5 Stratigraphic profiles for the northeastern and southeastern excavation areas.

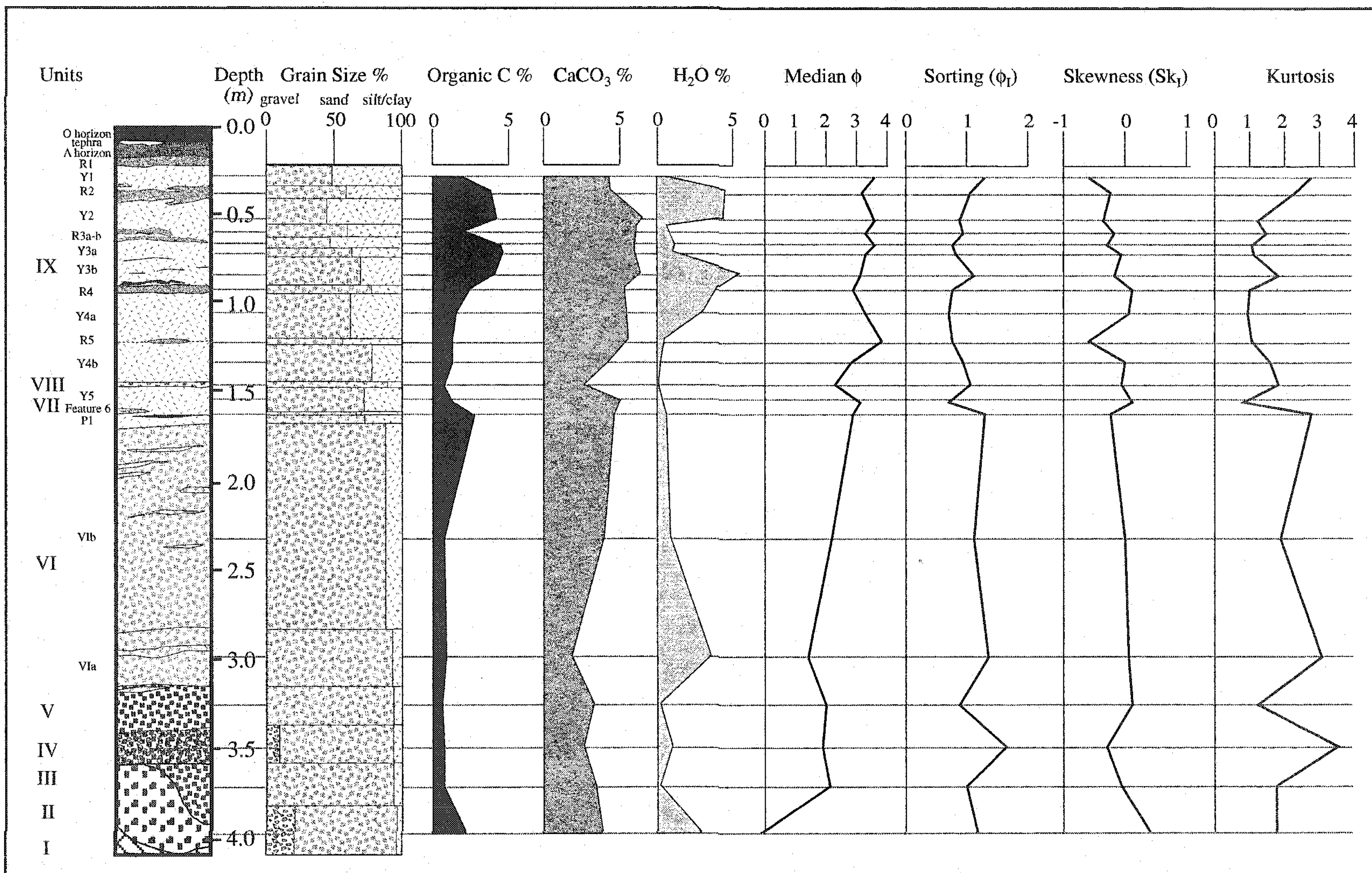

Figure 4.6 Granulometric and loss on ignition analysis results.

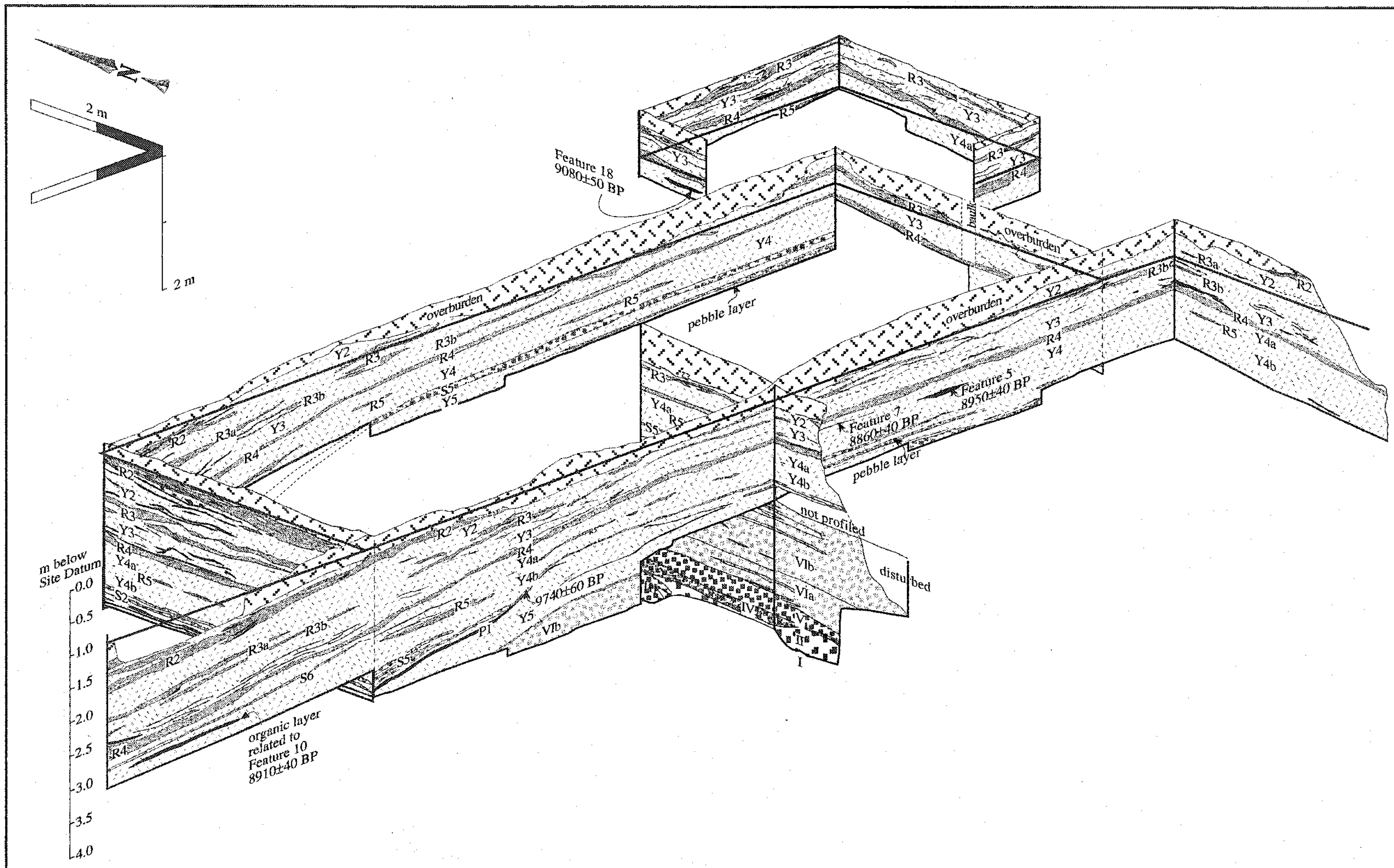

Figure 4.7 Fence diagram of main excavation area, view grid northeast (control line at 1.00 m below site datum).

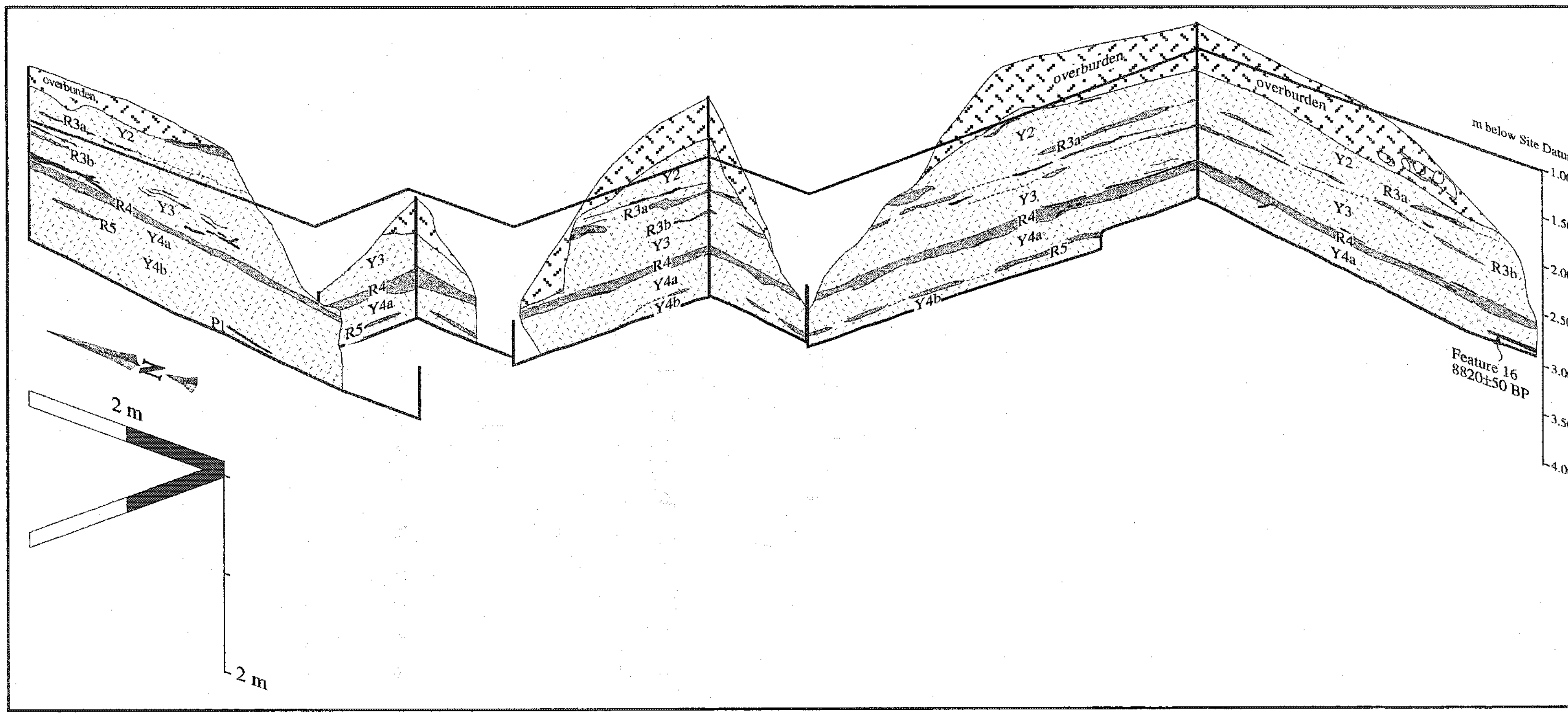

Figure 4.8 Fence diagram of southeastern area, Blocks J, Y, Z, and AA, view grid northeast (control line at 1.00 m below site datum)

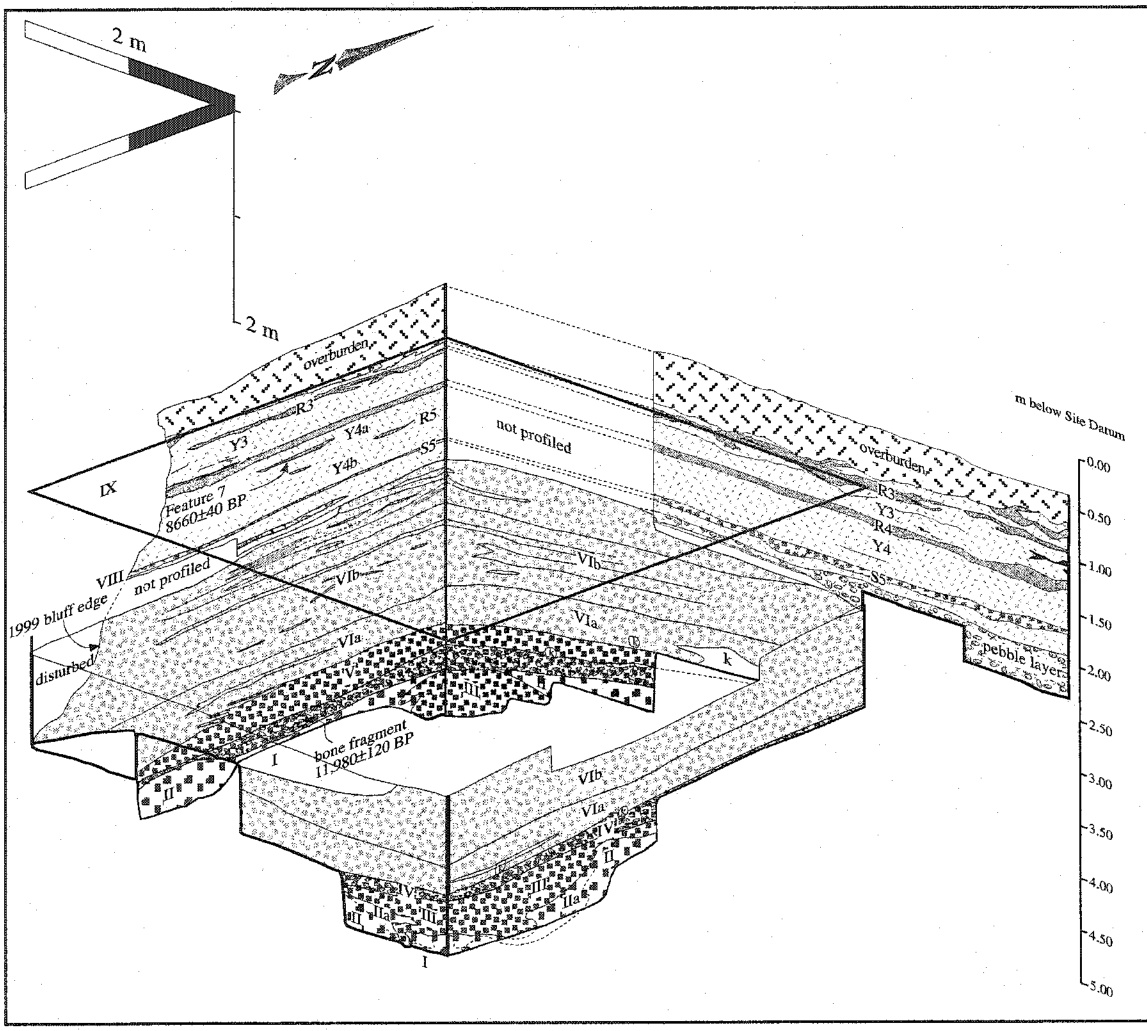

Figure 4.9 Fence diagram of lower sediments, Blocks O, P, Q, and R, view grid northwest (control line at 1.00 m below site datum).

Table 4.1 General description of stratigraphic units at Gerstle River Lower Locus.

Litho-strati-graphic Unit	*Sub-Unit (stratum)*	*Description*
IX, Upper Loess	Overburden	Disturbed spoil, <50 years old
	O horizon	Absent at Lower Locus due to surface clearing. O horizon.
	Tephra	Tephra, light brownish gray (10YR 6/2). Absent at Lower Locus due to surface clearing.
	A horizon/R1	Silt, dark grayish brown (10YR 4/2), cumulative A horizon. Absent at Lower Locus due to surface clearing.
	Y1	Silt loess, mottled yellowish brown (10YR 5/4), massive, with compressed wood stringers and discontinuous charcoal lenses, some rootlets. Mostly absent at Lower Locus due to surface clearing.
	R2	Silt loess, reddish-brown (7.5YR 4/4), discontinuous Ab horizon overlying Bwb horizon, consisting of decomposed organic material and abundant charcoal fragments; lower boundary abrupt and wavy, upper boundary abrupt and smooth
	Y2	Silt loess, mottled yellowish brown (10YR 5/4), massive, with compressed wood stringers and discontinuous charcoal lenses, some rootlets.
	R3a-b	Silt loess, reddish-brown (7.5YR 4/4), discontinuous Ab horizon overlying Bwb horizon, consisting of decomposed organic material and abundant charcoal fragments; lower boundary abrupt and wavy, upper boundary abrupt and smooth. Bifurcates into R3a and R3b.
	Y3	Silt loess, mottled yellowish brown (10YR 5/4), massive, with compressed wood stringers and discontinuous charcoal lenses, some rootlets. Component 5.
	R4	Silt loess, reddish-brown (7.5YR 4/4), continuous Ab horizon overlying Bwb horizon, consisting of decomposed organic material and abundant charcoal fragments; lower boundary abrupt and wavy, upper boundary abrupt and smooth.
	Y4a	Silt loess, mottled yellowish brown (10YR 5/4), massive, some rootlets. Local expressions of sand layer about 10 cm below bottom of R4 in western section of site. Component 3 ~16-21 cm below R4, Component 4 ~8-10 cm below R4.
	R5	Silt loess, reddish-brown (7.5YR 4/4), discontinuous Ab horizon overlying Bwb horizon, consisting of decomposed organic material and abundant charcoal fragments; lower boundary abrupt and wavy, upper boundary abrupt and smooth.
	Y4b	Silt loess, yellowish brown (10YR 5/4), massive. some rootlets. Component 2 ~38-43 cm below bottom of R4.
VIII, Sand 5a-c		Medium sand, discontinuous at the Lower Locus, not present at the Upper Locus. Light brown (2.5Y 6/4). Expressed as three thin layers (Sand 5a-c) in the western part of the site and compressed to one layer in the eastern part of the site.
VII, Lower Loess	Y5a	Silty sand, yellowish brown (10YR 5/4), massive. Local expression of colluvial wash (Feature 6). Component 1 ~3 cm above P1.
	P1	Silt loess, paleosol complex, sometimes bifurcates.
	Y5b	Sandy loess, yellowish brown (10YR 5/4), massive.
VI, Sand 4	Sand 4b	Sand, yellowish brown (10YR 5/2), laminated
	Sand 4a	Sand, dark yellowish brown (10YR 4/2). Higher water content, coarser sand than VII
V, Sand 3		Sand, olive gray (5Y 5/1) without ventifacts), well sorted.
IV, Sand 2		Sand, olive gray (5Y 5/1) with ventifacts, poorly sorted, similar matrix as V
III, Sand 1		Sand, olive gray (5Y 5/1), similar matrix as IV and V. C2 horizon.
II, degrading bedrock		Degrading bedrock (10YR 6/2), in some instances a coarse brown sand is present (IIa). C1 horizon
I, weathered bedrock		Weathered granodiorite, grayish-brown (10YR, 5/2). R horizon.

Table 4.2 Gerstle River site granulometric analysis.

Unit, Subunit	*Depth below surface (cm)*	*%Gravel*	*%Sand*	*%Silt+Clay*	*%H_2O*	*%Carbon*	*%$CaCO_3$*	*Median ϕ*	*Sorting*	*Skewness*	*Kurtosis*
IX, Y1	22-32	0.00	48.00	52.00	0.53	1.86	4.25	3.6	1.32	-0.58	2.75
IX, R2	32-45	0.00	59.00	40.00	4.43	3.76	4.41	3.2	1.07	-0.24	2.30
IX, Y2	45-57	0.00	44.33	55.00	4.32	4.16	6.50	3.6	0.87	-0.37	1.23
IX, R3a	57-60	0.00	60.00	40.00	0.65	2.16	6.02	3.3	0.94	-0.17	1.48
IX, R3b	62-65	0.00	47.45	52.00	1.14	4.50	5.93	3.6	0.75	-0.28	1.08
IX, Y3a	65-77	0.00	63.00	37.00	0.99	4.56	5.92	3.3	0.81	-0.09	1.11
IX, Y3b	77-88	0.00	70.00	31.00	5.33	4.10	6.35	3.1	1.10	-0.20	1.85
IX, R4	88-95	0.00	78.44	22.00	3.95	2.55	5.25	2.9	0.79	0.11	0.99
IX, Y4a	95-120	0.00	62.33	38.00	3.03	1.64	5.45	3.3	0.71	0.03	0.94
IX, R5	120-123	0.00	56.22	45.00	0.56	1.29	5.58	3.8	0.75	-0.56	1.08
IX, Y4b	123-143	0.00	77.24	23.00	0.25	1.31	4.26	2.8	0.96	0.00	1.60
VIII, Sand 5	143-146	0.00	89.10	11.00	0.11	0.76	2.62	2.3	1.06	-0.07	1.84
VII, Y5	146-165	0.00	72.35	27.00	0.36	1.36	5.03	3.1	0.69	0.12	0.81
VII, P1	160-161	0.00	66.00	34.00	0.69	2.74	4.58	2.9	1.29	-0.22	2.79
VIb, Sand 4b	165-285	0.00	88.22	12.00	0.96	0.83	4.01	2.2	1.11	0.01	1.89
VIa, Sand 4a	285-320	0.00	93.00	7.00	3.51	0.88	1.91	1.4	1.34	0.06	3.04
V, Sand 3	320-340	0.00	94.21	6.00	0.29	0.69	3.23	2.0	0.90	0.10	1.23
IV, Sand 2	340-360	10.00	82.00	7.00	1.05	0.84	2.62	1.9	1.65	-0.31	3.52
III, Sand 1	360-390	0.00	93.00	6.00	0.21	0.82	3.41	2.1	1.00	-0.05	1.78
II, degrading bedrock	390-410	21.00	75.00	3.00	2.83	2.23	3.87	-0.1	1.18	0.38	1.78

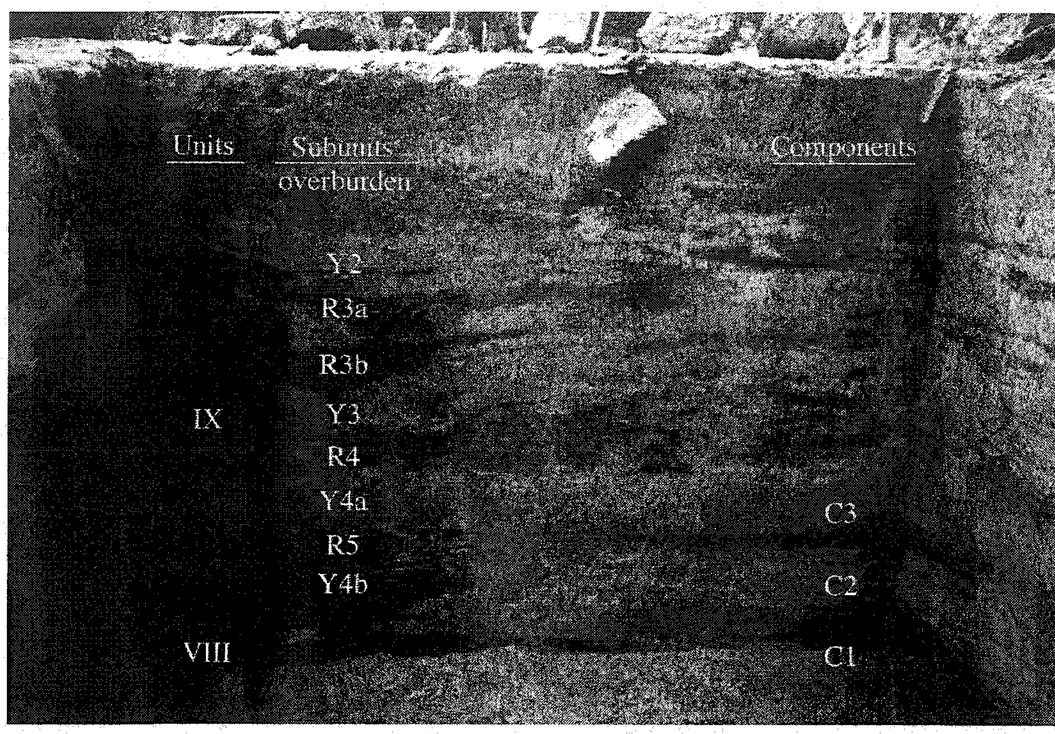

Figure 4.10 Stratigraphy at Block K (main excavation area), view grid west.

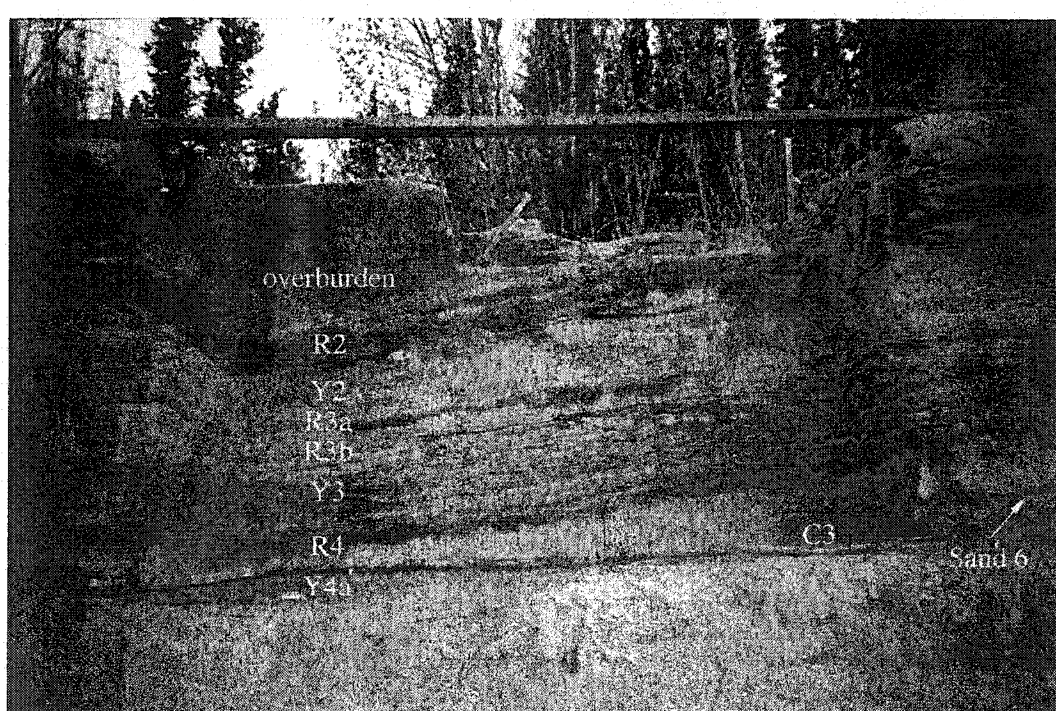

Figure 4.11 Stratigraphy at Block V (western excavation area), view grid north.

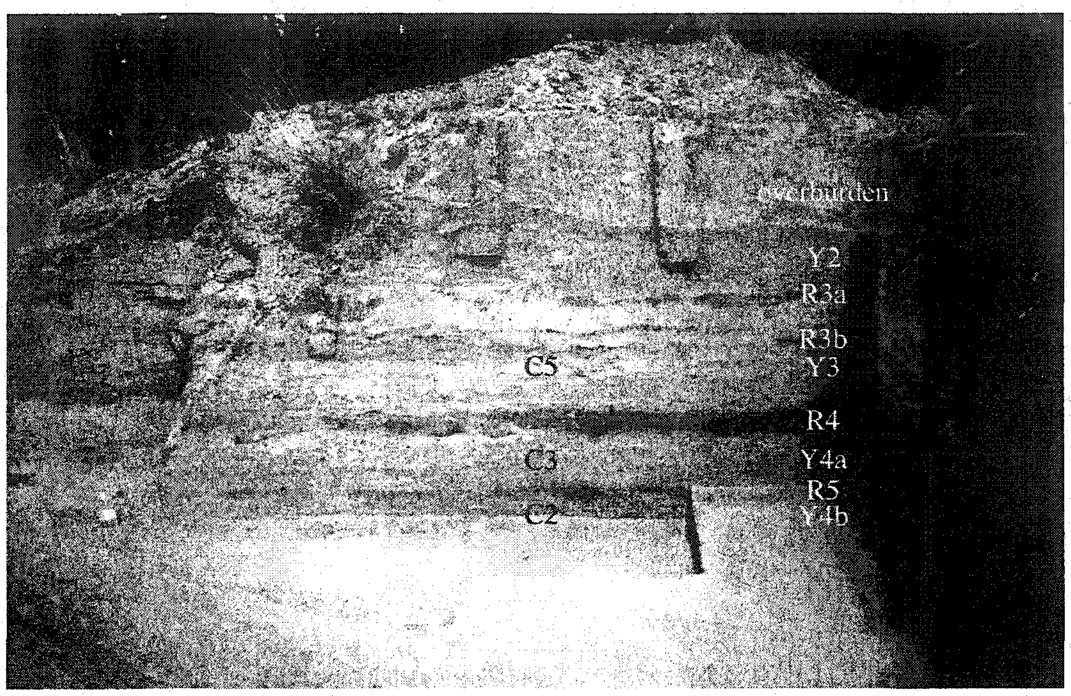

Figure 4.12 Stratigraphy at Block Y (southeastern excavation area), view grid north.

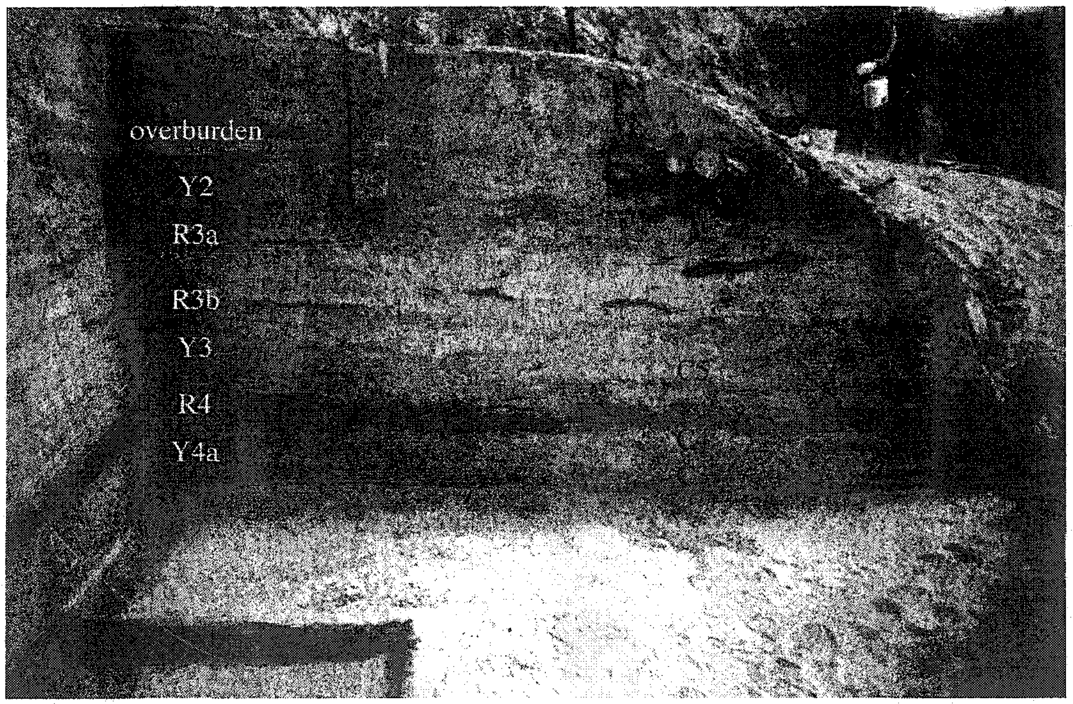

Figure 4.13 Stratigraphy at Block Y (southeastern excavation area), view grid east.

Figure 4.14 Lower sediments (Units I-VIb) in the main excavation area, view grid north. The 4 m^2 at left were excavated to bedrock (Unit I) and the 4 m^2 at right were excavated to the surface of Unit V. The orange line is horizontal at 3.0 m below site datum.

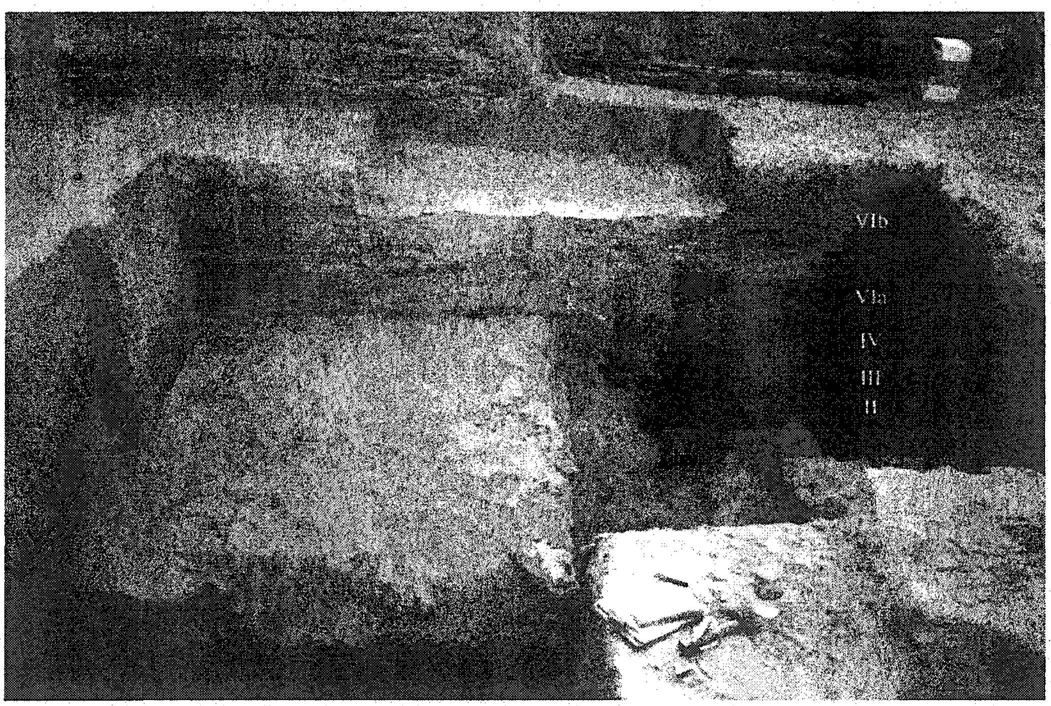

Figure 4.15 Lower sediments (Units II-VIb) in the main excavation area, view grid east. The 4 m^2 at right were excavated to bedrock (Unit I) and the 4 m^2 at left were excavated to the surface of Unit V. The orange line is horizontal at 3.0 m below site datum.

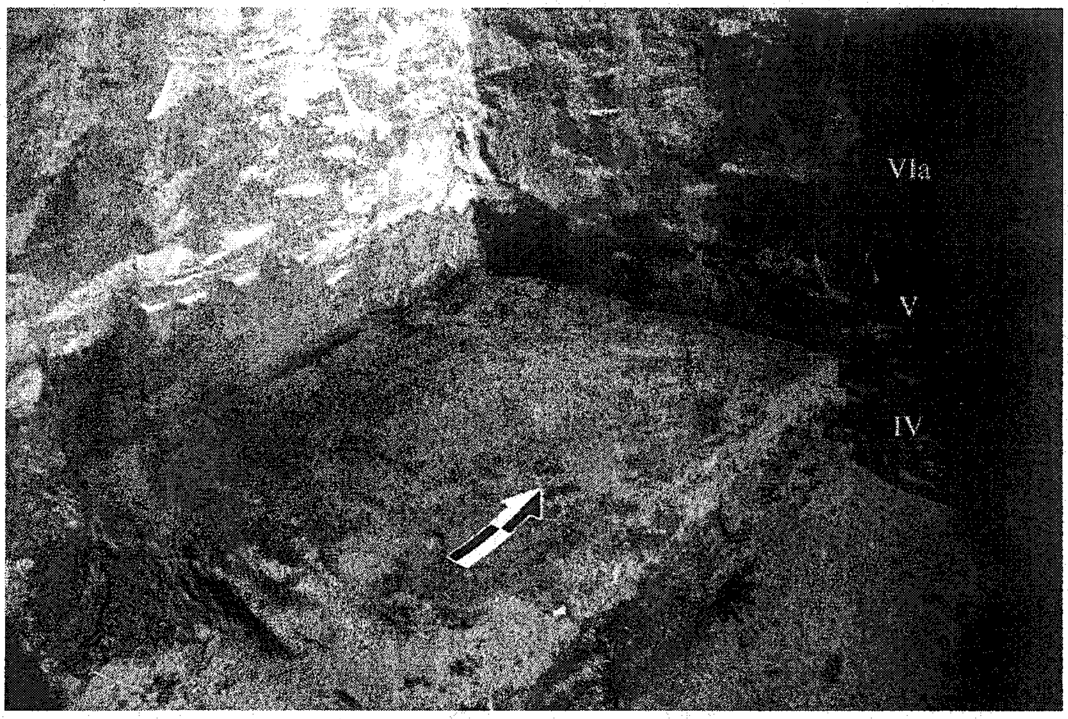

Figure 4.16 Krotovinas within Unit V, view grid northwest (see Figure 4.14 for completed excavation).

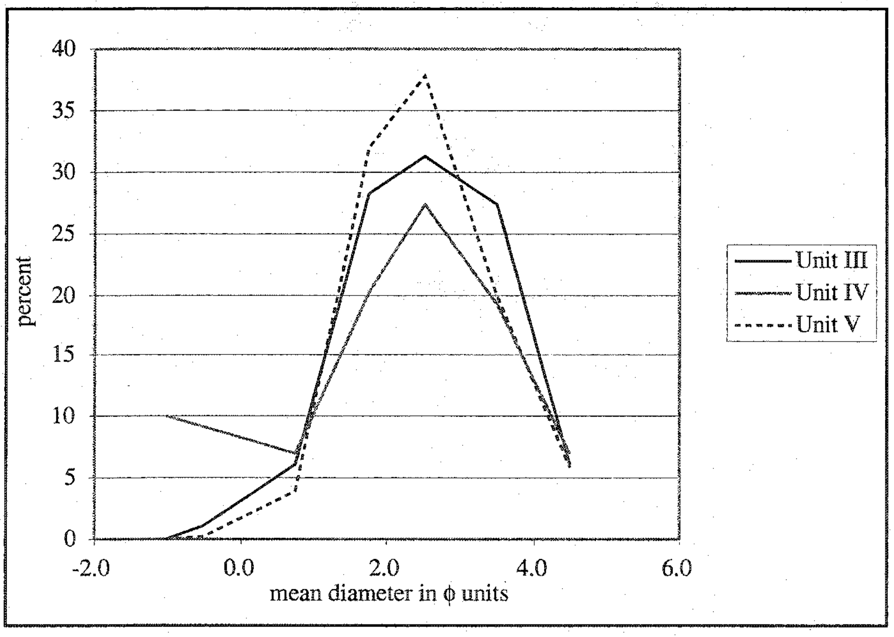

Figure 4.17 Units III-V mean grain size distributions.

Unit VI, aeolian sand

Overlying the grus (Unit V, designated Sand 4) is a thick layer of poorly sorted aeolian sand (Unit VI), between 165-320 cm below surface (Figures 4.14-4.15). The contact is abrupt and interfingered, the only interfingering observed in all of the strata at the site. The sand is divided into two subunits: Unit VIa is located between 165-285 cm below surface and is characterized as dark yellowish brown (10YR 4/2) medium sand, Unit VIb is located between 285-320 cm below surface and is characterized as yellowish brown (10YR 5/2) fine sand (see Figure 4.14). Both subunits are similar in that they contain 10+ continuous sand layers (granulometrically similar, but with less water content), but Unit VIa contains more water content and less carbonates than Unit VIb. The sand layers are between 3-10 cm thick, horizontal, and display low angle horizontal bedding. Krotovinas were observed within Unit VIa and lower units (IV and V), but did not extend into Unit VIb or higher in the main excavation area (see Figure 4.16). A krotovina was noted in the 1996 Bluff Test Pit by Holmes within Unit VIb or VII, but that test pit was located further to the west of the main excavation area. Water content is quite high within Unit VIa, decreasing in underlying and overlying units. Organic carbon and carbonate content was low.

No radiocarbon dates are available for Unit VI, but the lower limiting date of 12000 BP on Unit V and the 10000 BP dates on Unit VII indicates that this aeolian deposition lasted 2000 radiocarbon years (see Chapter 5). The timing of this sand deposition is interesting. Broken Mammoth and Mead sites, located in similar settings further down the Tanana River, have dates of 11600 BP for the termination of sand deposition and the development of paleosols. The period from 11600-10000 BP saw episodic loess deposition and the development of periodic cryorthents (Dilley 1998). During this period, the highest amount of sand deposition occurred at Gerstle River, indicating local variation in aeolian deposition.

Unit VII, Lower Loess

Overlying the Unit VI sand is a massive aeolian loamy sand (Unit VII, designated Lower Loess). Each strata within Units VII and IX exhibit increasing finer grained particles with decreasing depth, and are termed loesses even though some of the individual strata have >50%

very fine sand. Unit VII, also termed Stratum Y5, is a moderately well sorted, fine skewed, platykurtic very fine sand located between 146-165 cm below surface. Unit VII is 20±7 cm thick (15 data points). Median ϕ is 3.1, with considerably smaller particles than underlying aeolian sands. The silty sand is yellowish brown (10YR 5/4) and massive, with noticeably fewer iron oxide mottling than the overlying loess (Unit IX). Contact with the underling Unit VI sand is gradual and smooth and contact with the overlying Unit VIII sand is abrupt and smooth. Unit VII contains a paleosol complex (termed P1), a locally expressed colluvial wash feature (Feature 6), and lithic artifacts and bones of the lowest component (Component 1).

Paleosol 1 consists of one or two paleosol stringers (Abk horizon, see Dilley 1998:278) within Unit VII, sometimes bifurcating but mostly expressed as one thin (<5 cm thick) organic rich stringer located at 160-161 cm below surface. It is well developed at the western portion of the site, in the 1996 Bluff Test Pit and Blocks C, D, and G, but becomes fainter in the eastern part of the site, and is barely visible in Blocks T and X. Two radiocarbon dates have been obtained from samples within Paleosol 1 at the Lower Locus and one from the Upper Locus. A date of 9970±60 BP was derived from Paleosol 1 from the Bluff Test Pit in 1996 (Holmes 1998a). A date of 9740±50 BP was derived from a sample in Block E in 1999. The Upper Locus date of 10040±60 BP on Paleosol 1 is contemporaneous with the 9970±60 BP date, and a pooled average for this stratum is 9893±35 BP (see Chapter 5). A second paleosol (P2) was identified at the Upper Locus (Holmes 1998a), and may be represent a bifurcation of Paleosol 1 seen in along the bluff edge in 1996 and in Block E (see Figures 1.14 and 4.3). The spike in organic carbon and carbonates associated with Paleosol 1 is apparent in Figure 4.6. A twig of *Picea* spp. was found in Paleosol 1 (David McMahan 2005 personal communication).

A pebbly layer is located at 155-158 cm below surface, about 5 cm above Paleosol 1 (Figure 4.19). This pebbly layer was designated *Feature 6* given the early uncertainty as to the process responsible for its formation. This layer contains numerous granules and pebbles of granite (parent material was likely local bedrock) less than 1 cm in diameter, with a paucity of rocks between 1-4 cm, and 126 angular cobbles ranging in diameter from 4 to 17 cm in diameter (Figure 4.18). All pebbles or cobbles larger than 4 cm were sketched and collected with top and bottom measurements in addition to horizontal measurements. Lithic artifacts and faunal material from Component 1, the earliest component at the site, were located in direct association with this pebbly layer. The distribution of lithic artifacts and cobbles are spatially patterned. More cobbles were found west of Block N, and more lithic artifacts were found east of Block N, though there was considerable overlap (see Figure 4.18).

The cobbles were identified as fine-grained and coarser grained granite, and though some of the cobbles were exfoliating and crumbling while others were finer grained and intact, they were identified as coming from a similar source by UAF geologists Don Triplehorn and Mary Keskinen. Therefore, it is likely the cobbles derived from the local bedrock. Outcrops of bedrock were present in the undisturbed section of the hill south of the site area (Balvin 1962).

The cobbles were generally horizontal, though a few ranged between 10° and 60° from their largest flattest plane. In Block J, the pebble layer lay between 60 and 70 cm below R4. The excavator observed a gradient of decreasing concentrations of pebbles and artifacts from N48E48 to N46E48, suggesting that the layer was thinning further to the south, but our excavation was interrupted by the edge of the eroded bluff face at about N45.50.

During the winter of 2000, the entire cobble feature excavated to that point (n=72 cobbles and large pebbles) were placed on a paper grid in the Anthropology Department at UAF in order to assess any patterning (Figures 4.20-4.21). No readily identifiable pattern was observed, except the spatial patterning of flakes and cobbles described above. The cobbles were largely of local bedrock (angular granite) and no river worn cobbles were identified. This suggested that the origin of the materials was local to the hillside, further supporting the hypothesis of a natural origin. Furthermore, the lack of a definite pattern and the presence of numerous tiny pebbles suggested that humans did not bring this material to the site. A number of hypotheses were explored, such as windbreak feature(s), pebble floor layer of a structure to aid drainage, etc. However, the patterning did not support these cultural hypotheses.

One of the main objectives of the 2001 work was to identify the nature of this cobble layer. That it was horizontally localized was clear from the 1999 work. Very few cobbles were found within the trench at Blocks C, D, and G. A large block excavation was excavated in 2001, showing that indeed the cobble layer thinned and was not present in the northwestern part of the site (see Figure 4.18). However, the Component 1 artifacts were still found in stratigraphic association with the cobble layer in the northeast portion of the site (Blocks R, T, and U). Given time limitations, I did not excavate entirely through the cobble layer in the northeastern part in 2001, though I believed we had excavated through all of Component 1 (see below).

The 2002 and 2003 work focused on two objectives with respect to this cobble feature. The first was to continue the excavation to bedrock to identify the stratigraphic thickness of this layer. The second was to continue the excavation to the northeast and follow Component 1 in this direction to discern if the cobble layer was thicker upslope. If it was thicker upslope, that would support the hypothesis that this cobble layer was colluvial slope wash. If the cobble layer thinned out or disappeared, this would support the hypothesis that this was a cultural feature. The 2002-2003 work revealed that in fact the pebble and cobble layer was thicker than previously thought in the northeastern part of the site (i.e., upslope). In addition, more materials from Component 1 were recovered well below those recovered in 2000 and 2001. The data demonstrate a continuous distribution of Component 1 throughout this cobble layer (see Figure 4.18). The vertical position of the Component 1 artifacts further supported the hypothesis of disturbance after the deposition of these cultural items. While Components 2, 3, 4, and 5 all had relatively narrow vertical distributions (between 2-10 cm), Component 1 clearly had a larger vertical spread, about 13 cm between N48.50 and N53.00, but increases to about 40 cm south of N48.50.

After the 2003 field season, there were a total of 126 cobbles and large pebbles recovered from this cobble feature. All cobbles recovered from this layer and the distribution of the pebble layer is illustrated in Figure 4.18, along with a backscatter plot for the entire length of Feature 6 (N48-N52) for the area between E45-E48. No size sorting was evident in the cobble distribution, and the thickest distribution of pebbles was in the northeast. The association of lithic items, bone fragments, and the Feature 6 cobbles can be seen in the backscatter plot. Artifacts are interspersed with cobbles throughout the feature's length. Most of the cultural items are concentrated in N48-50, E46-48 units, in an area with relatively few large cobbles.

The stratigraphic position of this feature is within a silty sand (stratum Y5a) and about 5 cm above Paleosol 1. Unfortunately, Paleosol 1 was difficult to discern in the northeastern part of the site, so it is uncertain whether this feature transected Paleosol 1, i.e., cut through the older buried soil in this area. However, from stratigraphic data obtained from the central and central-western part of the site (Blocks B, C, D, E, F, G, N, O, P), indicate that the cobble layer does not lie below Paleosol 1 in these areas.

Thus, the spatial position of cobbles and Component 1 artifacts suggests that Feature 6 is a natural feature. The interpretation of colluvial slope wash is based on (1) the topography of the pebble layer and the natural slope (inferred from other continuous strata), flowing from northeast to southwest, (2) the dimensions and morphology of the feature, thinner near the edges and thicker near the center, and (3) the vertical displacement of the Component 1 lithic artifacts. The pebble layer lies within aeolian loess, with no evidence of alluvial deposits. A definitive

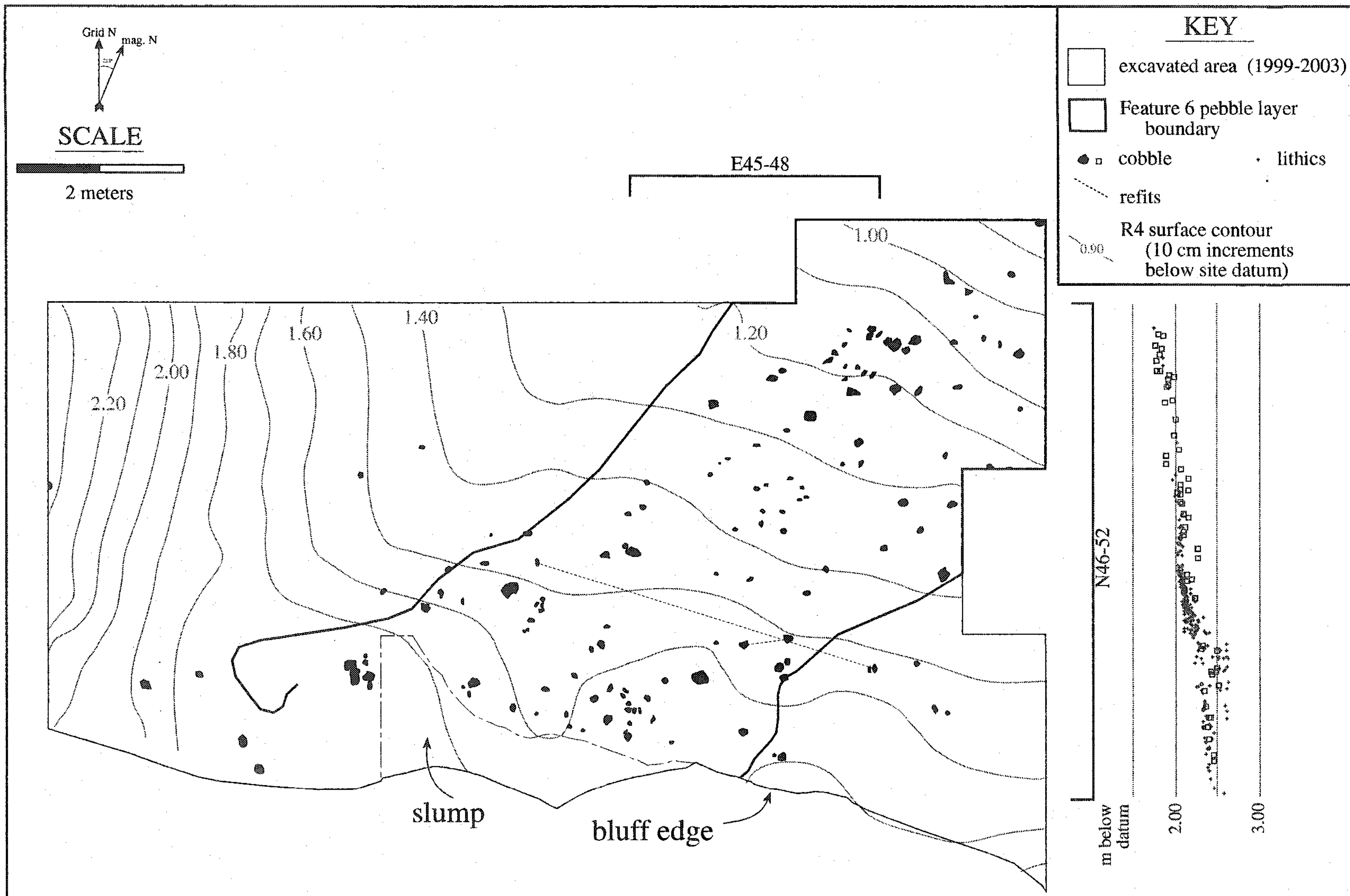

Figure 4.18 Spatial distribution of pebbly layer (Feature 6) within Stratum Y4b.

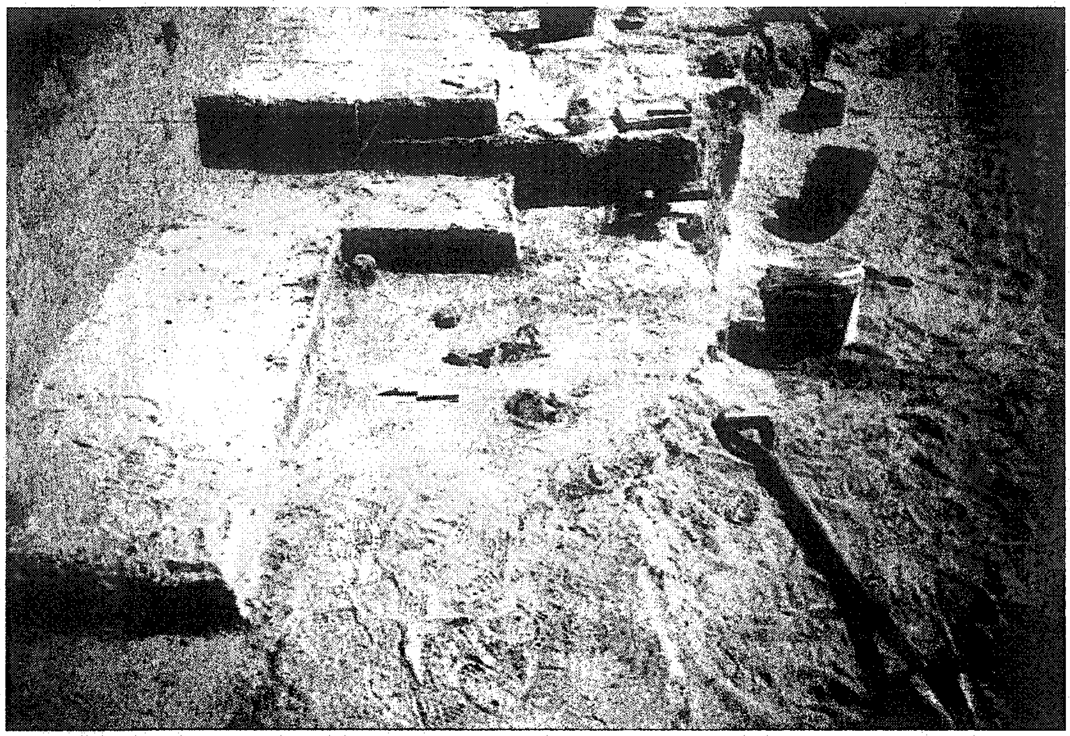

Figure 4.19 Feature 6 cobbles in Block N at the bluff edge (2000 excavation), view east.

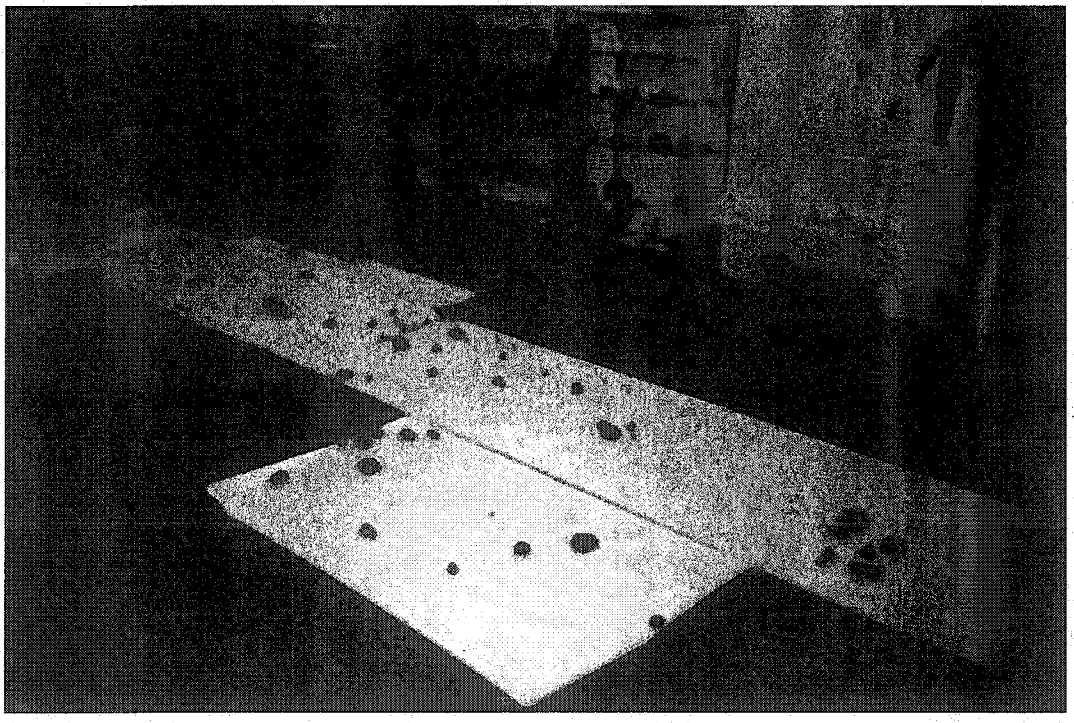

Figure 4.20 Feature 6 reconstruction (1999-2000 cobbles), view southeast relative to site grid.

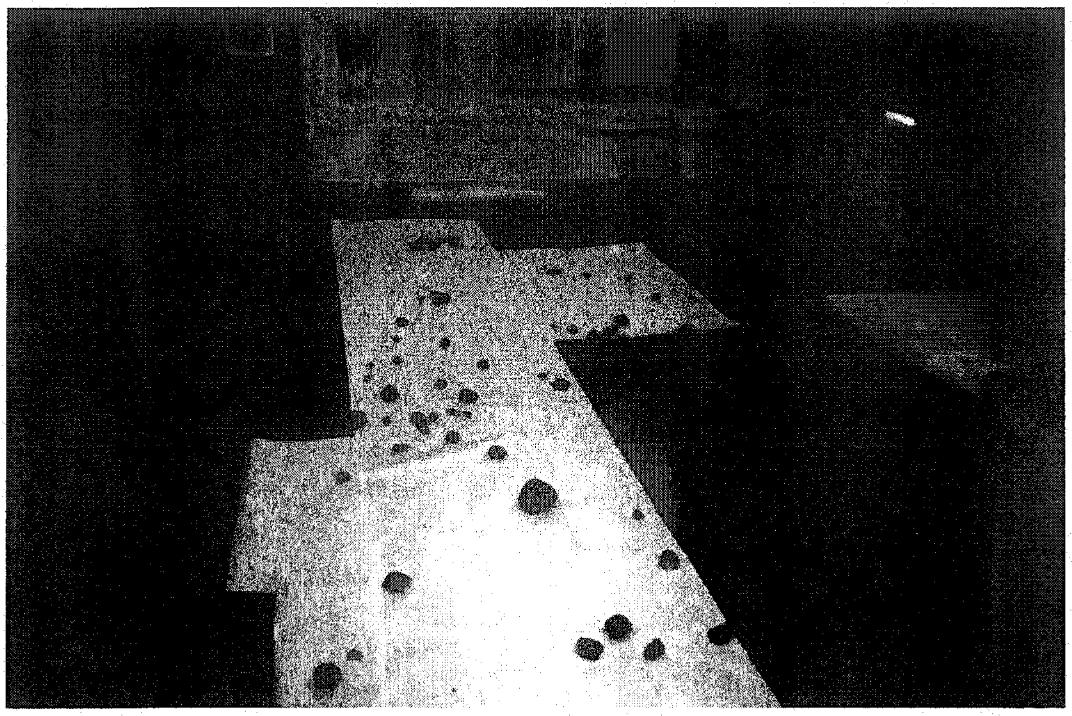

Figure 4.21 Feature 6 reconstruction (1999-2000 cobbles), view west relative to site grid.

explanation can be obtained by further excavation upslope (i.e., northeast). This colluvial slope wash model predicts that the dimensions obtained from the uncovered feature will be similar upslope, i.e., thinner at the edges and thicker in the center, as well as potentially being thicker nearer to the base of the backslope.

Unit VIII, aeolian sand

Overlying the Unit VII loess is a medium aeolian sand (Unit VIII, designated Sand 5). This sand is present throughout the Lower Locus, but is expressed as three distinct layers in the western portion of the site (Blocks C, D, and G), and is compressed to one layer in the eastern portion of the site (Blocks T and X) (Figures 4.3-4.4, 4.7). Unit VIII is located between 143-146 cm below surface, and was 9±6 cm thick (though the average is skewed by the very thick sand layers in Blocks C and G). The upper and lower boundaries of this sand are abrupt and nearly smooth. Each layer was distinct in the western part of the site on the basis of coarseness with the silty sand above and below, though the color was the same between the sand layers, 2.5Y 6/4 (light brown). No cobbles or pebbles were found within this layer. Analysis of each sand layer and a sample of the coarser sand between them show differences among the units. The lowest sand layer (Sand 5a) is moderately sorted, symmetrical, and very leptokurtic, with a median ϕ = 2.3. The middle sand layer (Sand 5b) is poorly sorted, symmetrical, and leptokurtic, with a median ϕ = 2.3. The upper sand layer (Sand 5c) is moderately sorted, symmetrical, and very leptokurtic, with a median ϕ = 2.8. A sample of the sediment between Sand 5a and 5b is the most divergent of all samples within this unit, and is poorly sorted, coarse skewed, leptokurtic, with a median ϕ = 2.0. The sample from the uppermost sand layer (Sand 5c) is very similar to the loess in stratum Y4b. Organic carbon and carbonate content was low, and water content was very low within Unit VIII.

No charcoal was found within Unit VIII, and no radiocarbon dates are available for this unit, however bracketing dates are available from the layers above and below. Paleosol 1 within stratum Y5 has been dated to 9893±35 BP (see above and Chapter 5), and two hearths within stratum Y4b produced contemporaneous dates averaging 9449±41 BP (see Chapter 5), thus indicating that the deposition of this sand occurred between 9900 and 9450 years BP.

Unit IX, Upper Loess

Overlying the Unit VIII sand is a massive aeolian silt loess (designated Unit IX, Upper Loess) (Figures 4.10-4.13). Unit IX is located between 0 and 143 cm below surface and is mottled yellowish brown (10YR 5/4), interbedded with a number of buried soil horizons, tephra, and a modern soil. Each stratum within Unit IX exhibits increasing finer grained particles with decreasing depth. At the Lower Locus, the modern soil, tephra, and one or more buried horizons is absent due to the clearing of surface sediments in the 1960s, but these strata are well described for the Upper Locus (Dilley 1998:278). Organic carbon and carbonates generally increase from Y4b (9449 BP) to R2 (5050 BP). Water content is low in the lower Unit IX sediments (Y4b-Y4a), but peaks within Y3b and again within Y2-R1, with intervening sediments with low water content (Y3a-R3a). Water content and organic carbon content show positive correlation, while carbonates form relatively high percentages throughout Unit IX.

Because of the complexity of the stratigraphy, the association of numerous radiocarbon dates and cultural materials, each of the strata within this unit are discussed separately. Figures 4.10-4.13 show stratigraphic photographs from the three main areas of the site for Unit IX.

Stratum Y4b

Overlying the Unit VIII sand is a massive compact aeolian loamy sand (stratum Y4b) located 123-143 cm below surface. Stratum Y4b thickness, measured from the bottom of stratum R4 to Sand 5 is 27±9 cm (from 20 data points). The loess is moderately sorted, composed of 66% fine and very fine sand and 23% silt/clay, it is symmetrical, and very leptokurtic. The loess is a yellowish brown (10YR 5/4) with many medium mottles, with some rootlets, but very few charcoal or wood fragments. No cobbles or pebbles were found within this layer. The lower boundary of stratum Y4b is abrupt and smooth. This stratum is very similar to stratum Y4a in color and texture, and in the absence of the stratum R4 Bwb horizon, a clear distinction cannot be made. However, there are some differences in granulometry. Y4b particles are larger than Y4a (median ϕ of 2.8 and 3.3 respectively) and grain sizes show a more peaked distribution, though both are moderately sorted and show symmetrical distributions.

Component 2 cultural material is located within Y4b at 133-137 cm below surface (~40 cm below the bottom of stratum R4 and ~5 cm below the bottom of stratum R5). No paleosol is located at the same level as Component 2 artifacts, but a clearly defined surface can be extrapolated based on the three-dimensional plots of cultural materials (see below). The slope and aspect of Component 2 materials is nearly identical with Component 3 materials within Y4a and the R4 surface contours suggesting even deposition across the site. Two radiocarbon dates were obtained on hearth features within Component 2, resulting in statistically identical ages, yielding a pooled average of 9449±41 BP for stratum Y4b (see Chapter 5).

Stratum R5

Stratum R5 is a single discontinuous Bwb soil horizon characterized by oxidized staining of the mottled aeolian loess (stratum Y4) located between 120-123 cm below surface. There is no clearly defined Ab horizon associated with this straum, but small highly fragmented charcoal specks were found in areas where the oxidization was strongly represented (brown, 7.5 YR 4/4) (see Figure 4.10). The sandy loam associated with R5 is moderately sorted, strongly skewed towards fine particles, and mesokurtic, with a median ϕ of 3.8, much higher than Y4a or Y4b (3.3 and 2.8 respectively), and is composed of 45% silt/clay (vs. 38% and 23% for Y4a and Y4b). The upper boundary of the soil is abrupt and nearly smooth and the lower boundary is abrupt and wavy. Stratum R5 is undated, but bracketing dates of 9449±41 BP on Y4b and 9130±40 BP as the oldest date associated with Y4a suggests soil development between 9500-9100 years BP (see Chapter 5).

Stratum R5 is different from the other Bwb horizons in that it does not contain an Ab horizon, and was likely formed in a very different environment. The bracketing radiocarbon dates and the macrofossil analysis indicates this soil developed prior to widespread spruce forests in the area. A wood specimen from R5 was identified by David McMahan as Populus/Salix group. Given the rise in *Populus* pollen documented at Birch Lake dated to 9300-8100 BP (Bigelow 1997), this horizon may indicate an amelioration of the climate, with less wind activity and development of a poplar forest at the site during the earliest Holocene.

Stratum Y4a

Stratum Y4a is a massive compact aeolian sandy loam located 95-120 cm below surface. Stratum Y4b thickness, measured from the bottom of stratum R4 to the surface of stratum R5 is 25±5 cm (from 31 data points). Since R5 was discontinuous, a larger sample of data points gives a thickness average of all of Y4 as 50±9 cm (37 data points). The loess is moderately sorted, composed of 59% fine to very find sand and 38% silt/clay, and is symmetrical and very leptokurtic. The loess is a yellowish brown (10YR 5/4) with many medium mottles, with some rootlets, but few non-cultural charcoal or wood fragments. Very few pebbles and no non-cultural cobbles were found in this stratum. The upper boundary of stratum Y4b with the overlying Bwb horizon (R4) is clear and slightly wavy (width/depth of pockets are ~10 cm/3 cm). In the western part of the site, where the stratigraphy is the deepest (Block V), a sand layer was noted at 10 cm below the bottom of stratum R4. This sand layer was ~10 cm above the Component 3 materials in this area. The sand layer could be followed on the walls from N48E34 to N48E39 where it was too thin to follow.

Components 3, the largest at the site in terms of artifact and bone density and feature frequency, is situated within stratum Y4a at 112-116 cm below surface, or ~16-21 cm below the bottom of R4. Component 4 is located at two discrete locations at around 98-103 cm below surface or ~8-10 cm below the bottom of R4. Similar to the Component 2 occupation, no paleosol is present within stratum Y4a. The slope and aspect of Component 3 and 4 materials is nearly identical with the R4 surface contours indicating that a surface existed with little subsequent distortion. A series of 14 radiocarbon dates have been run on samples from stratum Y4a at the Lower Locus, ranging in age from 8660±50 BP to 9130±40 BP suggesting deposition span of less than 500 radiocarbon years.

Stratum R4

Stratum R4 is a single distinctive continuous Bwb soil horizon characterized by oxidized staining of the mottled aeolian loess (7.5YR 4/4, brown), and is located between 88-95 cm below surface (Figure 4.22). Average thickness of R4 was 8±3 cm (69 data points). An Abk horizon directly overlies this stratum, containing numerous large and small organic material fragments, including burned and unburned woody fragments. This is the distinctive soil horizon at the site, and is present in every excavation unit. This layer has abundant decomposed organic material, charcoal fragments, and diffuse organic matter. No pebbles or non-cultural cobbles were found in this stratum. The loamy sand associated with R4 is moderately sorted, fine skewed, and mesokurtic, with a median ϕ of 2.9, more similar to Y3b than Y4. The upper boundary is abrupt and smooth, and the lower boundary is clear and wavy (width/depth of pockets are ~10 cm/3 cm).

Two radiocarbon dates from samples associated with R4 at the Lower and Upper Locus were contemporaneous and yielded a pooled average of 8337±43 BP (see Chapter 5). Macrofossils associated with this horizon indicate that this soil developed from a spruce forest. Several wood specimens from stratum R4 were identified as *Picea* spp. (David McMahan 2005 personal communication). Ager and Brubaker (1985) dates the Picea-Betula Zone to 9500-8400 BP, and the dating on stratum R4 suggests that spruce forests were established in the Gerstle River area towards the end of this time range. Above this stratum, there are numerous paleosol stringers, charcoal fragments, and diffuse organic matter suggesting a forested regime of soil development and burning. Below this stratum, the relative lack of soil formation and the massive loess suggest a different vegetation pattern, dominated by birch and willow.

Because R4 is present throughout the site, given its proximity to the main cultural occupation (Component 3), and the lack of well-defined strata within Y4a, the surface contours of R4 (Abk horizon) are used to infer the ground surface at the time of Component 2, 3, and 4 occupations. Figure 4.22 illustrates the contours and profiles for the surface of R4. The aspect is generally southwest at about 8°. The slope from northwest to southeast (at the eastern portion of the site) is 7.8°, with a decrease in slope at Block Y. The topography shows a relatively gradual slope to Block E, with a steeper grade within Blocks C, D, and G, flattening out again at Block V. This topography seems to be reflected in the distribution of cultural materials in Components 1, 2, and 3. The densest concentrations of materials are in the main area up to the beginning of the steep slope in Blocks C, D, and G. Other concentrations occur at Blocks V and Y where the slope becomes more gradual.

Stratum Y3

Stratum Y3 is a massive compact aeolian sandy loam located 65-88 cm below surface. Stratum Y3 thickness, measured from the boundary with the lowest R3 Bwb horizon to the surface of R4 is 37±8 cm (from 71 data points). There are two distinct subunits to stratum Y3, a lower unit with numerous organic stringers (termed Y3b, 65-77 cm below surface) and an upper unit with few organic remains (termed Y3a, 77-88 cm below surface). Stratum Y3b is poorly sorted, coarse skewed and very leptokurtic, composed of 50% very fine sand and 31% silt/clay, with a median ϕ of 3.1. Stratum Y3a is moderately sorted, symmetrical and leptokurtic, composed of 51% very fine sand and 37% silt/clay, with a median ϕ of 3.3. Y3b shows a bimodal distribution with the predominant peak at 50% very fine sand and 7% coarse sand, unlike any of the other Unit IX strata. Both units are yellowish brown (10YR 5/4) with many medium mottles. No pebbles or non-cultural cobbles were found in this stratum. The lower boundary with R4 is abrupt and smooth and the upper boundary with R3b (where the latter occurs) is clear and wavy. A wood fragment from one of the organic stringers in stratum Y3b was identified by David McMahan as *Picea* spp., indicating spruce continued to constitute part of the vegetation during the loess deposition episodes.

A number of faunal remains are found within stratum Y3b associated with Component 5, located at 80-85 cm below surface. Stratum Y3 is undated, and while bracketing dates of 8337±43 BP on R4 and 7600±140 BP on stratum R3b yield an unweighted average of 7969 BP for Component 5, the loess accumulation and soil development lasted for several hundred years (see Chapter 5).

No cultural materials were located above Y3b at the Lower Locus, though Components 6 and 7 are associated with strata Y2 and Y1 respectively at the Upper Locus (Potter 2002).

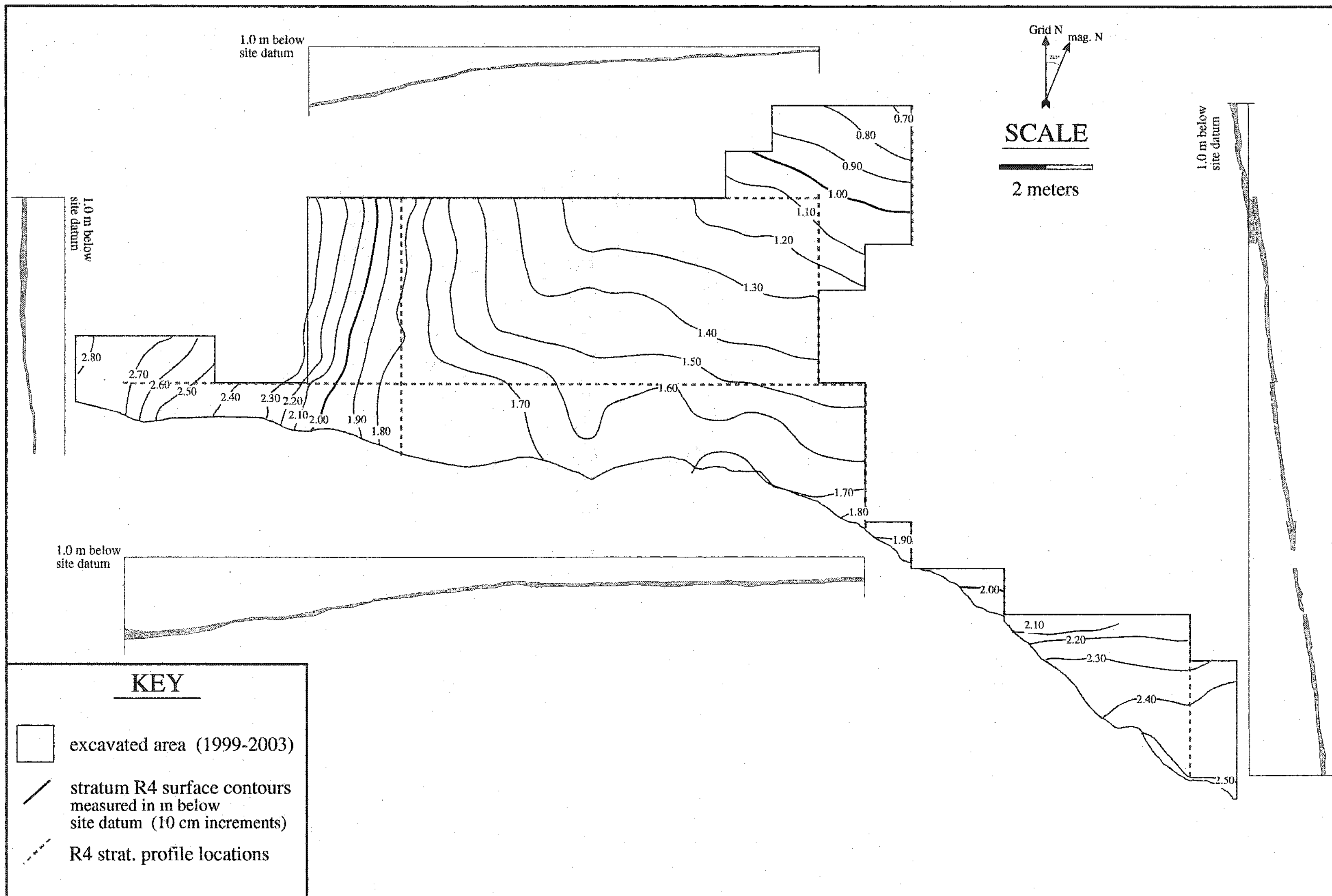

Figure 4.22 Stratum R4 surface contours.

Stratum R3

Stratum R3 frequently is represented by two distinct, discontinuous Abk/Bwb horizons, termed R3a (upper) and R3b (lower) located 57-65 cm below surface, characterized by oxidized staining of the mottled aeolian sandy loam (7.5YR 4/4). R3 thickness is generally ~5 cm for each horizon. Charcoal fragments and diffuse organic matter are found throughout R3a and R3b, but thin Abk horizons can be distinguished above and below in several areas. No pebbles or non-cultural cobbles were found in this stratum. Stratum R3a is moderately sorted, coarse skewed, and leptokurtic, with a median ϕ of 3.3. Stratum R3b is moderately sorted, coarse skewed, and mesokurtic, composed of 39% very fine sand and 52% silt/clay, with a median ϕ of 3.6. The upper and lower boundaries are clear and smooth to slightly wavy. Two radiocarbon dates from samples associated with R3a at the Lower and Upper Loci were contemporaneous and yielded a pooled average of 6239±51 BP. A single date associated with R3b at the Upper Locus yielded a date of 7600±140 BP. Wood samples from stratum R3a and R3b were identified by David McMahan as from the Betula group and *Picea* spp. respectively.

Stratum Y2

Stratum Y2 is a massive compact aeolian silt loam located 45-57 cm below surface. The loess is a yellowish brown (10YR 5/4) with many medium mottles, containing diffuse organic matter, though with few organic rich stringers. The loess is moderately sorted, strongly skewed towards coarse particles, and leptokurtic, composed of 52% silt/clay and 31% very fine sand with a median ϕ of 3.6. Site disturbance has resulted in the removal of the upper strata at the Lower Locus, but in places where Y2 appears, the upper and lower boundaries with Bwb horizons (R2 and R3a) are abrupt and generally smooth. No radiocarbon dates are associated with this stratum at the Lower Locus (see Chapter 5).

Stratum R2

Stratum R2 is composed of a number of Abk/Bwb soil horizons characterized by oxidized staining of the mottled aeolian loess (7.5YR 4/4, brown), and is located between 32-45 cm below surface. Thickness of R2 varies, but ranges between 10-40 cm. In rare cases up to three Abk/Bwb horizons can be distinguished, but in most cases a single Abk/Bwb is expressed. This layer has abundant decomposed organic material, charcoal fragments, and diffuse organic matter. The lower and upper boundaries are abrupt and smooth. The sandy loam associated with R2 is poorly sorted, coarse skewed, and very leptokurtic, composed of 40% silt/clay, 29% very fine sand, and 18% fine sand, with a median ϕ of 3.2. A radiocarbon date of 5050±90 BP is associated with this stratum at the Upper Locus.

Stratum Y1

Stratum Y1 is a massive compact aeolian silt loam located 22-32 cm below surface. The loess is a yellowish brown (10YR 5/4) with many medium mottles, containing diffuse organic matter, though with few organic rich stringers. The loess is poorly sorted, strongly skewed towards coarse particles, and very leptokurtic, composed of 52% silt/clay and 26% ver fine sand, with a median ϕ of 3.6. Stratum Y1 displays a bimodal distribution with a peak at silt (52%) and coarse sand (6%). Site disturbance has removed almost all of Y1 at the Lower Locus. At the Upper Locus, artifacts were associated with this stratum, and two associated dates had contemporaneous ages, yielding a pooled average of 3842±62 BP (see Chapter 5).

Other Strata

While no evidence of the uppermost strata is available at the Lower Locus, extrapolation from the Upper Locus indicates an O horizon-A-Bw sequence of a modern Cryochrept soil at 0-32 cm below surface (Dilley 1998:278). A tephra was located below the O horizon (7-11 cm BS). There are currently no radiocarbon assays associated with the uppermost strata (Surface to Y1) at Gerstle River, at either Locus. Dilley originally identified the tephra as the northern lobe of the White River Ash (1998:233), but a sample was sent to James Begét, who conducted microprobe analysis and found that the tephra displayed an unknown composition (Begét, personal communication 2000). The tephra remains undated, but is younger than 3842±62 BP (see above).

The overburden was variable at the Lower Locus, but after mechanical removal of much of the overburden in 1999 (see Chapter 3), the remaining overburden generally 25-75 cm thick. Thickness increased from east to west, with some of the undisturbed sediments (Y2) exposed at the furthest northeast excavation area (Blocks T, X). The lower boundary of the disturbance is very abrupt and smooth. Large cobbles (flyrock from previous blasting), wire, plastic, and other modern debris were found throughout the overburden.

Granulometry

Hierarchical cluster analysis of granulometric data and a cumulative grain size curve chart were used to identify groupings among strata, labeled in arabic numerals for the former and letters for the latter. Several clustering methods were used, including Ward's (inner squared distance), median, centroid, within group, between groups, furthest neighbor (complete linkage), and nearest neighbor (single linkage). All produced analogous results, and only the Ward's method clustering is illustrated here (Figure 4.23). Four groups of sediments were identified on the basis of grain size distributions. Group 1 consists of Unit II, differentiated from the other sediments on the basis of high percentage of gravels (21%) and coarse sand (37%). Group 2 consisted of all sand units below Unit VII (Units III-VIb), characterized by similar frequencies of medium and fine sand (20-40% each). Group 3 consisted of P1, Y4b, R4, and R2 within the upper and lower loess, characterized by relatively poorly sorted fine sand to silt (~30% in each ϕ category). Group 4 consisted of two sub-groupings, one characterized by very high frequencies of silt/clay (52-55% vs. 30-44%) (Y1?, Y2, and R3b) and the other characterized higher very fine sand frequencies (Y5a, R5, Y4a, Y3b, Y3a, and R3a).

Group 1 consists of coarse sand, suggestive of *in situ* weathering of the granitic bedrock. Group 2 occurs as a block as the lowest sediment layers at the site (from ~12000 BP to 10000 BP). The clustering of this group is primarily related to the dichotomy between the finer grained loess (Units VII and IX) and the lower coarser sands. Within this cluster, there are differences, where Units III, IV, V, and VIa are grouped based on the cumulative grain size chart (Figure 4.24) as Group B.

Five groupings were present based on the cumulative grain size curve chart (Figure 4.24). For the most part, these groupings reflected the hierarchical clusters. Group A consisted of Unit II and was equivalent to Group 1. Group B consisted of Units III, IV, V, and VIa and Group C consisted of Units VIb and VIII; together these were within Group 2. Group D consisted of Unit IX (Y4b and R4). Group E consisted of Unit VII (lower loess) and Unit IX (upper loess except

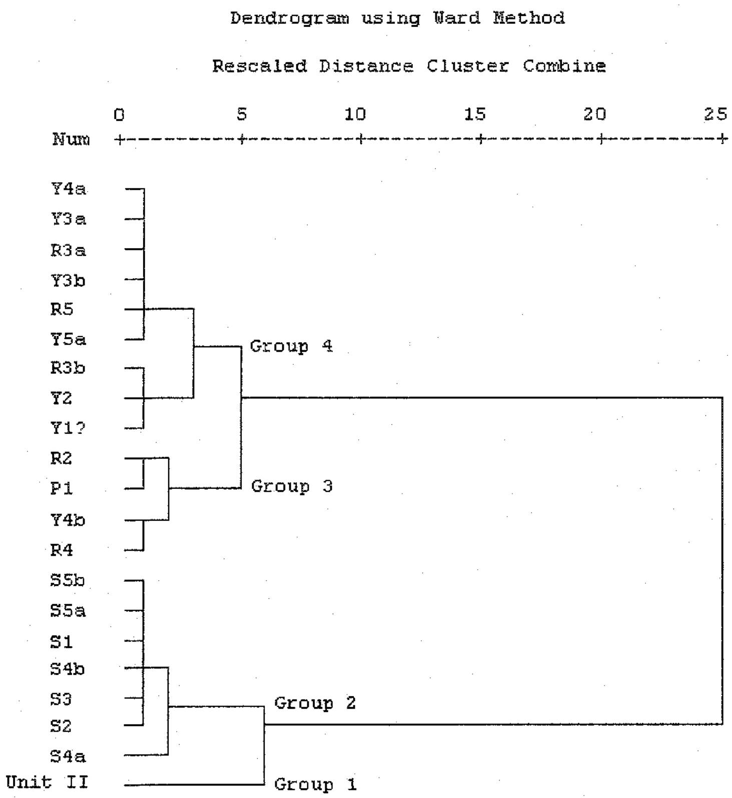

Figure 4.23 Hierarchical cluster analysis of granulometry.

Y4b and R4). Groups D and E were similar to coarser and finer grained loess particulates in Groups 3 and 4 respectively.

The two sand groups are stratigraphically patterned, with Group B represented by coarser grained materials up to Unit VIa, and Group C represented by finer grained sands above Unit VIa. This may represent a change in source material, but no radiocarbon dates are available for Unit VIa or VIb deposition. The presumed source for the Gerstle River Quaternary aeolian sediments are the outwash deposits for the Gerstle or Tanana Rivers. Three factors may account for decreasing sizes of particles transported as loess and deposited at the Gerstle River site: wind speed and direction, distance to loess source (outwash fans and denuded active river floodplains), and type of vegetation at the site. A change in paleochannels for either river may have denuded an area closer to the site during the early period of sand deposition. The spread of birch and later poplar and spruce may have also resulted in decreasing particle sizes as well as a smaller denuded area for the source material. Whatever the process, the dichotomy between the earlier aeolian sand

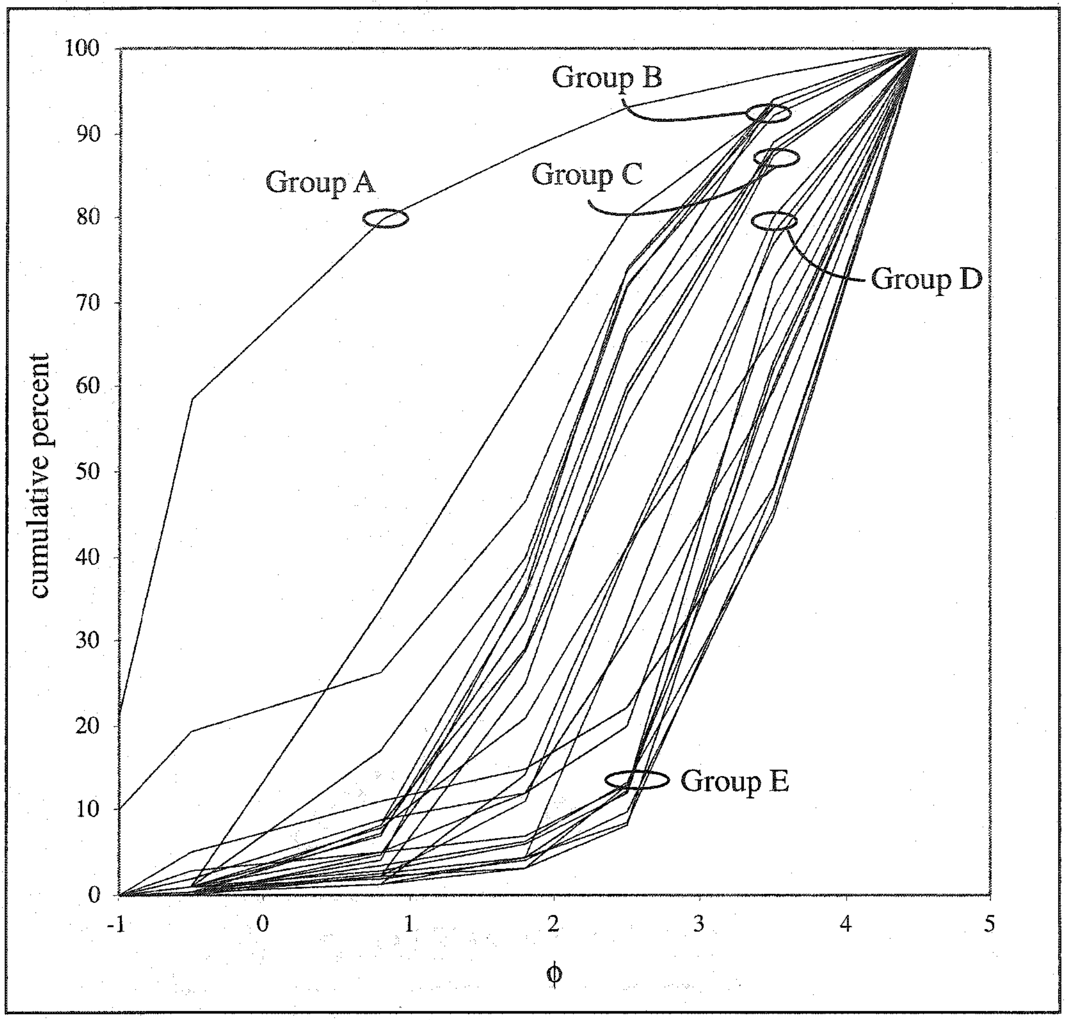

Figure 4.24 Cumulative grain size curves.

deposition (12000-10000 BP) and the later aeolian loess deposition (10000-8400 BP, see below) is clearly marked by the granulometry data.

There is considerable variability in grain size for the Upper Loess, ranging from moderately well sorted to poorly sorted, with distributions from coarse skewed to symmetrical to fine skewed, but the distributions are generally leptokurtic. There is no perfect correlation between age and coarser particle distributions, but there is a general trend of finer grained sediments after 6200 BP (R3a), and coarser grained sediments prior to this period. There is also no correlation between Bwb horizons and unoxidized massive aeolian loess with respect to grain sizes. Stratum R5 contains 44% silt/clay, whereas R4 has only 22% silt/clay.

Intra-Locus Stratigraphic Variability

While the overall stratigraphic sequence is nearly identical across the site, there are some differences in thickness of the upper loess between Bwb horizons and differences in number of expressed Bwb horizons for each R stratum. Stratigraphic profiles from the main area, the western area (Block V), and the southeastern area (Blocks Y, Z, and AA) are illustrated in Figure 4.25. Each of these stratigraphic profiles were oriented at the centroid of R4.

The western area is generally thicker in most deposits than the main area, and retains more of the upper strata; stratum R2 is well expressed. Unit VIII (Sand 5) is much thicker and is expressed as three discrete layers. Paleosol 1 is also much thicker compared with the main area. A thin sand horizon (Sand 6) is apparent about 10 cm below R4, and this could not be identified at either the main area or the southeastern area. While Y3 is thicker at the western area, Y4a and Y4b are similar in thickness. Y4a thickness does increase at N48E33-36 (see Figures 4.3, 4.7). The southeastern area is similar to the western area in that it has generally thicker deposits than the main area. The hearth matrices from the southeastern area (Feature 14) were lighter in weight by volume than hearths from the other areas (894 g/liter vs. 939-1040 g/liter) (Gelvin-Reymiller 2004), and differential compaction of the sediments in this area may explain the thicker deposits, whereas the western area may have received a higher sediment influx rate. To explore the differences in stratigraphy, sediment accumulation rates were examined.

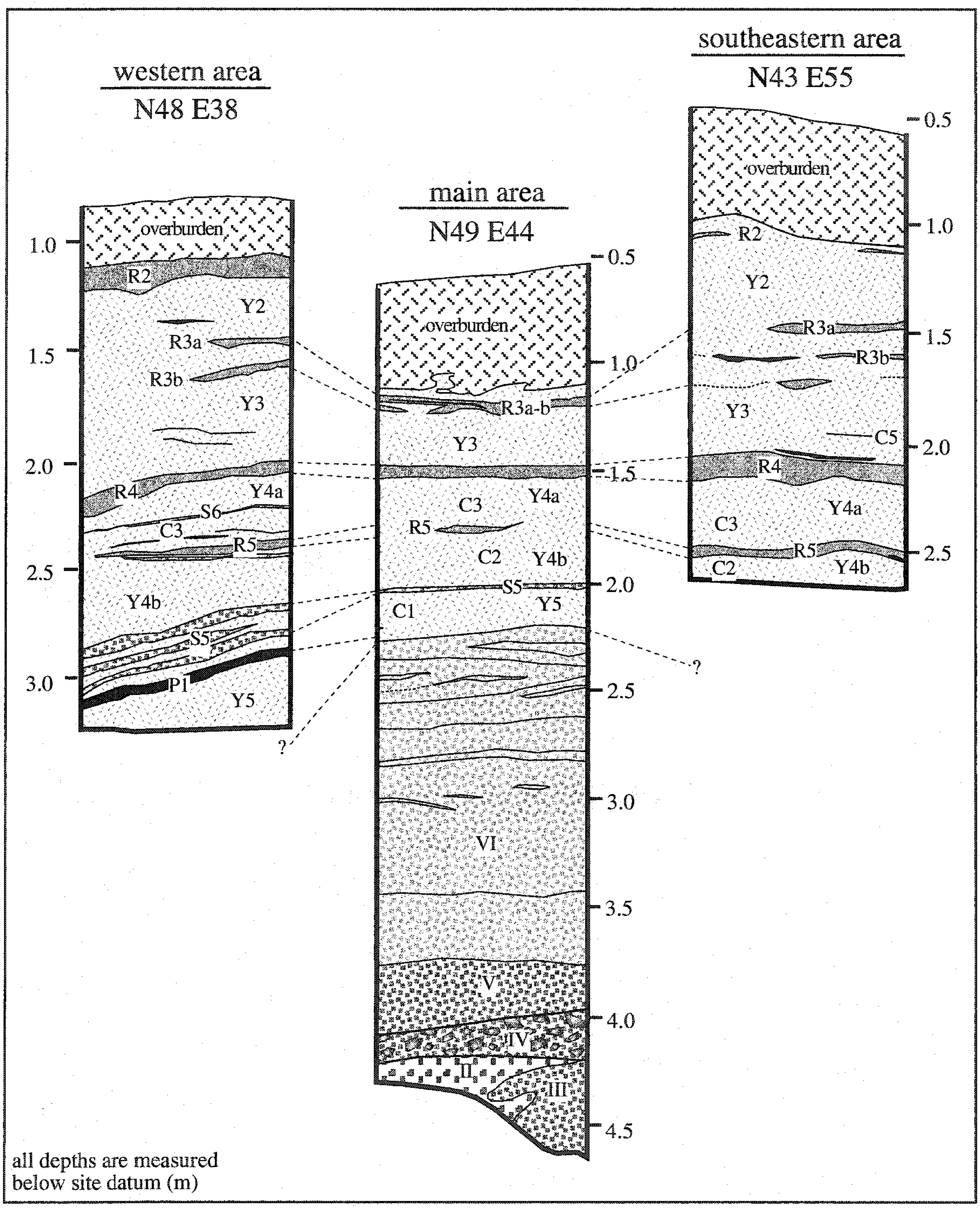

Figure 4.25 Intra-locus stratigraphic variability: main, western, and southeastern areas.

Sediment Accumulation Rates

The radiocarbon dating on various strata is considered sufficient to enable examination of absolute accumulation rates of sediments at Gerstle River. Following Stein, et al. (2003), total accumulation is the difference in depth between two radiocarbon-dated strata, and duration of accumulation is the difference in age between the two dates. Each rate is measured in cm/100 years and is calculated as:

Total accumulation rate = (d2 – d1/a2 – a1) x 100,

where, d2 is the depth of the upper sample, d1 is the depth of the lower sample, a2 is the age of the upper sample, and a1 is the age of the lower sample. This analysis assumes that deposition rates are even between radiocarbon-dated layers.

The rate is measured as cm/100 years. The radiocarbon dates are averaged if more than one date was available for the strata (see Chapter 5). The resulting dates are calibrated following procedures documented in Chapter 5. To obtain a central point for each age, the center intercept of the radiocarbon model (Stuiver et al. 1998) was used for odd number of intercepts, or the average of two center intercepts were used for even number of intercepts. In order to assess the standard error of the radiocarbon ages, error bars representing 2 σ for each calibrated or average age is provided in the graph (Figure 4.26).

Secure radiocarbon assays were present on nine strata: Y1, R2, R3a, R3b, R4, Y4a (at 8-12 cm below R4 and 16-21 cm below R4), Y4b (all within Unit IX upper loess), Paleosol 1 in Unit VII (lower loess), and Unit IV colluvium. Stratum Y1 had one associated date of 3800±65 BP, R2 had one associated date of 5050±90 BP, stratum R3a had two associated dates (averaging 6239±48 BP), stratum R3b had one associated date (7600±140 BP), stratum R4 had two associated dates (averaging 8339±38 BP), stratum Y4a had one date at 8-12 cm below R4 (Component 4) (8660±40 BP) and twelve dates at 16-21 cm below R4 (Component 3) (averaging 8926±14 BP), stratum Y4b had two associated dates (Component 2) (averaging 9456±35 BP), Paleosol 1 had three associated dates (averaging 9897±32 BP), and a bone fragment from Unit IV yielded a date of 11980±120 BP).

Measurements were made on the midpoints of each stratum (or the location of the radiocarbon date) under consideration. Depths below surface were obtained from the estimates from EU N4944 (west wall) for the Lower Locus and Test Pit 5 (east wall) from the Upper Locus (Table 4.3). EU N4944 was chosen for a number of reasons: (1) the unit was relatively horizontal from north to south, (2) the unit contained the strata of interest, though the position of P1 was extrapolated from adjacent profiles, (3) the unit contained the lower strata (to bedrock), (4) the unit was representative of the stratigraphy of the site, and (5) Components 1, 2, and 3 materials were located on all sides of this profile. The Upper Locus values were adjusted for 0.00 = ground surface. Ground surface measurement for the Lower Locus was derived from the procedure described above. Stratigraphic data for both loci are provided in Table 4.3 and the resulting deposition rates are presented in Table 4.4.

Table 4.3 Correlation of stratigraphic and radiocarbon data for both loci.

Stratum	*^{14}C Assay (BP)*	*Calibrated range (2σ) (cal BP)*	*Center calibrated intercept (cal BP)*	*Adjusted Lower Locus Depth below surface (m)*	*Adjusted Upper Locus Depth below surface (m)*
Surface	0	0	0	0.00*	0.00
Y1	3800±65	4413-3982	4174	0.27*	0.45
R2	5050±90	5988-5600	5828	0.39	0.55
R3a	6239±48	7265-7002	7168	0.59	0.85
R3b	7600±140	8639-8060	8390	0.64	1.00
R4	8339±38	9472-9151	9401	0.92	1.20
Y4a upper (C4)	8660±40	9710-9540	9593	1.01	1.30†
Y4a lower (C3)	8926±17	10186-9916	9985	1.14	1.35
Y4b (C2)	9456±35	11056-10564	10689	1.35	1.47
Paleosol 1	9897±32	11337-11201	11233	1.60	1.55
Unit IV	11980±120	15320-13618	13896	3.50	2.15
Bedrock	?	?	?	4.10	2.23

* estimated
† extrapolating between R4 and Y4a (C3)

Table 4.4 Deposition rates for both loci.

Event(s)	*Lower Locus Rate (cm/100 years)*	*Upper Locus Rate (cm/100 years)*
Deposition from Y1 to surface (4174 years)	0.65	1.08
Deposition between Y2 and Y1 (1654 years)	0.73	0.60
Deposition of Y2 (1340 years)	1.49	2.24
Deposition between formation of R3a and R3b (1222 years)	0.41	1.23
Deposition of Y3 below R3b (1011 years)	2.77	1.98
Deposition between occupation Component 4 and formation of R4 (192 years)	4.69	5.21
Deposition between occupations Components 3 and 4, including deposition of some of Y4a (392 years)	3.32	1.28
Deposition between occupations Components 2 and 3, including deposition of some of Y4b and Y4a, and formation of R5 (704 years)	2.98	1.70
Deposition between formation of Paleosol 1 up to occupation at Component 2, including deposition of Y5a, S2, and some of Y4b (544 years)	4.60	1.47
Deposition of Units IV, V, and VI (lower sands) (2663 years)	7.13	2.25
Aggregate Events		
Deposition of Y4 and Y5a (between Paleosol 1 and R4) (1832 years)	3.06	1.91
Deposition of Y3 (between R4 and R3a) (2233 years)	1.80	1.57
Deposition of sediments between R3a and surface (7168 years)	0.96	1.19
Deposition of Upper Loess (between Paleosol 1 and surface) (11,233 years)	1.51	1.38

Inter-Locus Accumulation Rates

There are three distinct periods of deposition rates apparent at the Lower Locus (Figure 4.26). The first period (14400-11200 cal BP) was characterized by a heavy influx of aeolian sand, at 4.60-7.13 cm/100 years. The second period (10700-8400 cal BP) showed somewhat lessened rates of loess deposition (2.77-4.69 cm/100 years). The final period, encompassing the later Holocene (8400 cal BP to present) is markedly reduced from the preceding periods (0.41-1.49 cm/100 years). These trends are reflected in less drastic differences at the Upper Locus. In general the rates are similar between loci (r=0.49), and the most extreme divergence is the deposition of the lower sands (2.25 vs. 7.13 at the Lower Locus) (Figure 4.27). There was no instance of reversals in the rates (i.e., when a rate increased from the preceding rate at the Lower Locus it also increased at the Upper Locus). Only two periods can be discerned at the Upper Locus, one between 14400 and 6000 cal BP (with rates between 1.23 and 5.21 cm/100 years), and a second after 6000 cal BP (with rates of 0.60-1.08 cm/100 years). Thus, while deposition rates are similar for the later Holocene, the Lower Locus saw increased deposition at various times during the Pleistocene/Holocene transition.

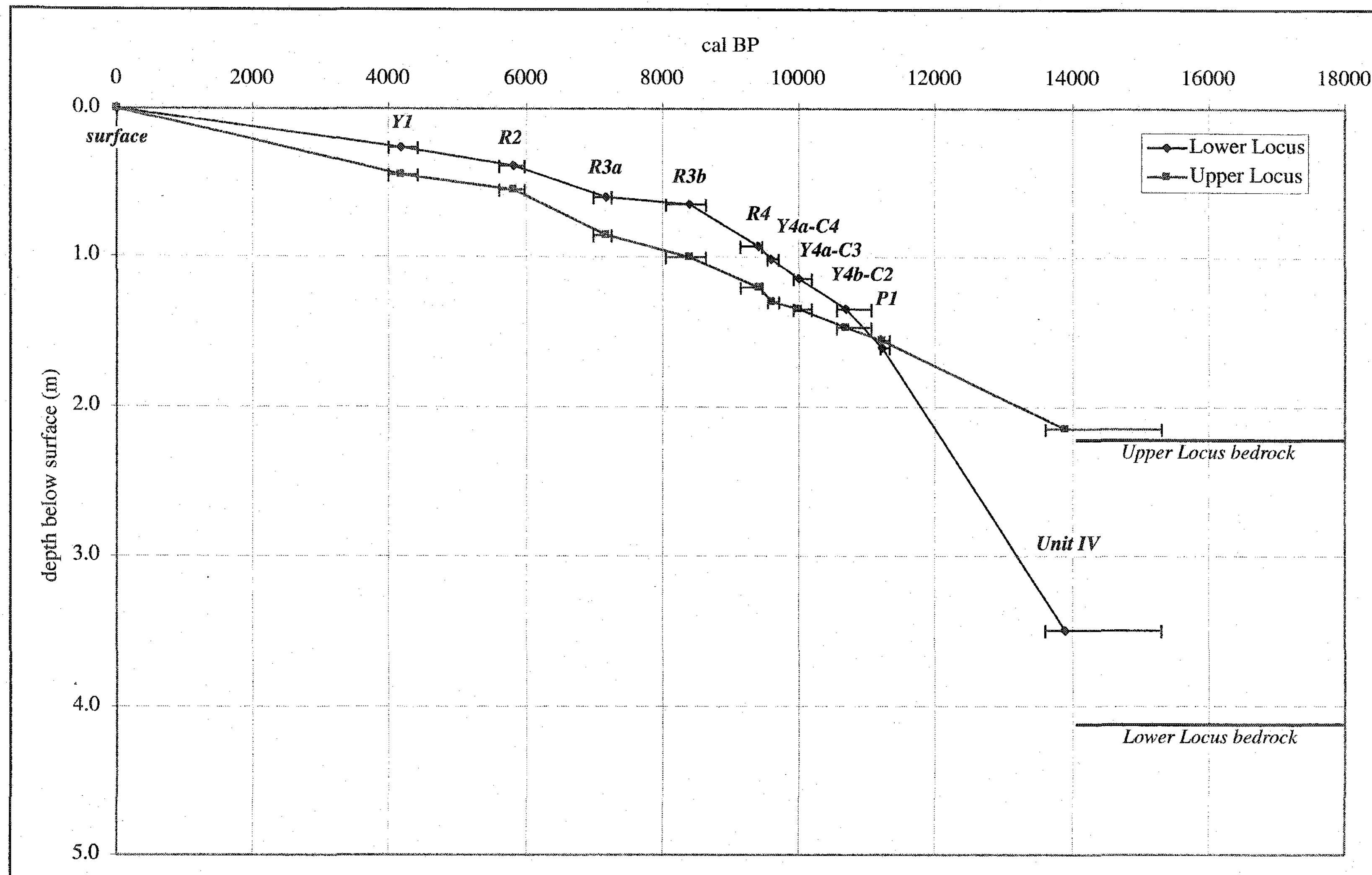

Figure 4.26 Upper and Lower Locus radiocarbon dates by depth.

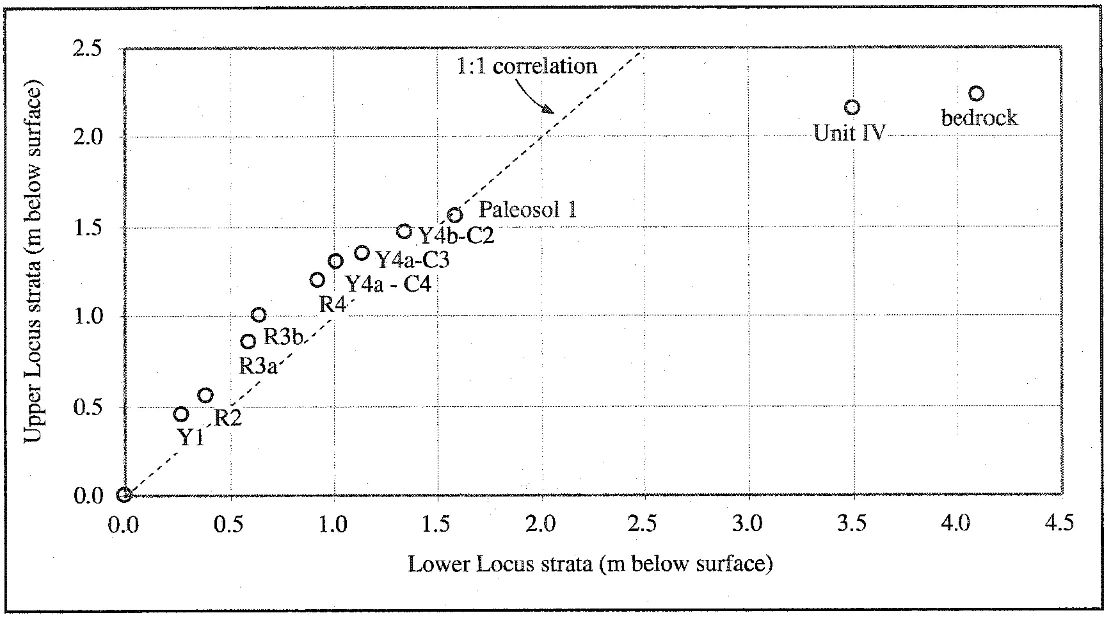

Figure 4.27 Upper and Lower Locus stratigraphic depth comparison.

A relatively heavy influx of sand is present at the Lower Locus between 14000 and 11200 cal BP, with a decrease during the occupations of Component 2 and 3 (10700-10000 cal BP). Deposition was greater after the occupation of C4 and prior to the formation of R4 (9600-9400 cal BP). The years after 9400 cal BP, but especially after 8400 cal BP, there is a marked decrease in sedimentation rates (from 2.77 cm/100 years to 0.65-1.49 cm/100 years), which continued until recent times.

The deposition of sediment at the Lower Locus in the period of interest, between formation of Paleosol 1 and R4 (inclusive of components 1, 2, 3, and 4), took place at almost 1 1/2 times the rate as the Upper Locus (3.06 cm/100 years vs. 1.91 cm/100 years respectively). The rate of deposition of Y3 was more similar between the loci (at 1.88 cm/100 years and 1.57 cm/100 years respectively). Overall, the sediment accumulation rates for the Holocene (Paleosol 1 to surface) were similar between the loci.

Intra-Locus Accumulation Rates

In order to understand possible intrasite differences in site formation processes at the Lower Locus, four areas were selected for examination of sediment accumulation, based on geomorphology of the Lower Locus and location of cultural concentrations. These include (1) N43E55, located in the far southeastern portion of the site and associated with Components 2 and 3, (2) N48E34, located in the far southwestern portion of the site with associated Component 3, (3) N54E50, located in the far northeastern portion of the site with associated Component 3, and (4) N48E42, located in the main area and associated with Components 1, 2, and 3. All four of these areas do not exhibit undisturbed surface, so these depths were calibrated on the N48E42 sample at 0.39 m above R2 for N43E55 and N48E34, and 0.59 m above R3a for N54E50.

Given the lack of Component 2 at most areas of the excavated site, I assigned an age to R5 for the purpose of estimating deposition rates. The closest dates on adjoining strata are 9130±40 BP and 9400±50 BP on Y4 above and below R5 respectively. Using a pooled average of 9238±35 BP calibrates to 10550-10242 cal BP (2σ) with a center intercept of 10403 cal BP. Table 4.5 and Figure 4.28 illustrate the results of the comparisons.

Accumulation rates are generally similar for the areas between the Component 2 occupation and deposition of Y3, encompassing Components 2, 3, and 4. The western and southeastern areas did have slightly higher values than the main and northeast areas. Deposition of Y2 is considerably higher for the western and southeastern areas than for the main area (2.99-3.88 vs. 1.49). Since both the western and southeastern areas are located further downslope than the main and northeast areas, these differences could relate to proximity (in elevation and distance) to the loess source. Given these data, the depositional environment among the areas at the Lower Locus were likely similar during the main occupations at the site (Components 2, 3, and 4).

Table 4.5 Deposition rates for Lower Locus areas (cm/100 years).

Event(s)	*Main area*	*W area*	*NE area*	*SE area*
Deposition of Y2 (1340 years)	1.49	3.88	N/A	2.99
Deposition between formation of R3a and R3b (1222 years)	0.41	0.82	0.65	1.23
Deposition of Y3 (1011 years)	2.77	4.55	3.56	4.76
Deposition between C3 occupation and formation of R4 (584 years)	1.54	3.62	3.42	4.11
Deposition between formation of R5 and C3 occupation (458 years)	2.84	N/A	1.54	3.28
Deposition between C2 occupation and formation of R5 (246 years)	8.54	N/A	N/A	1.22

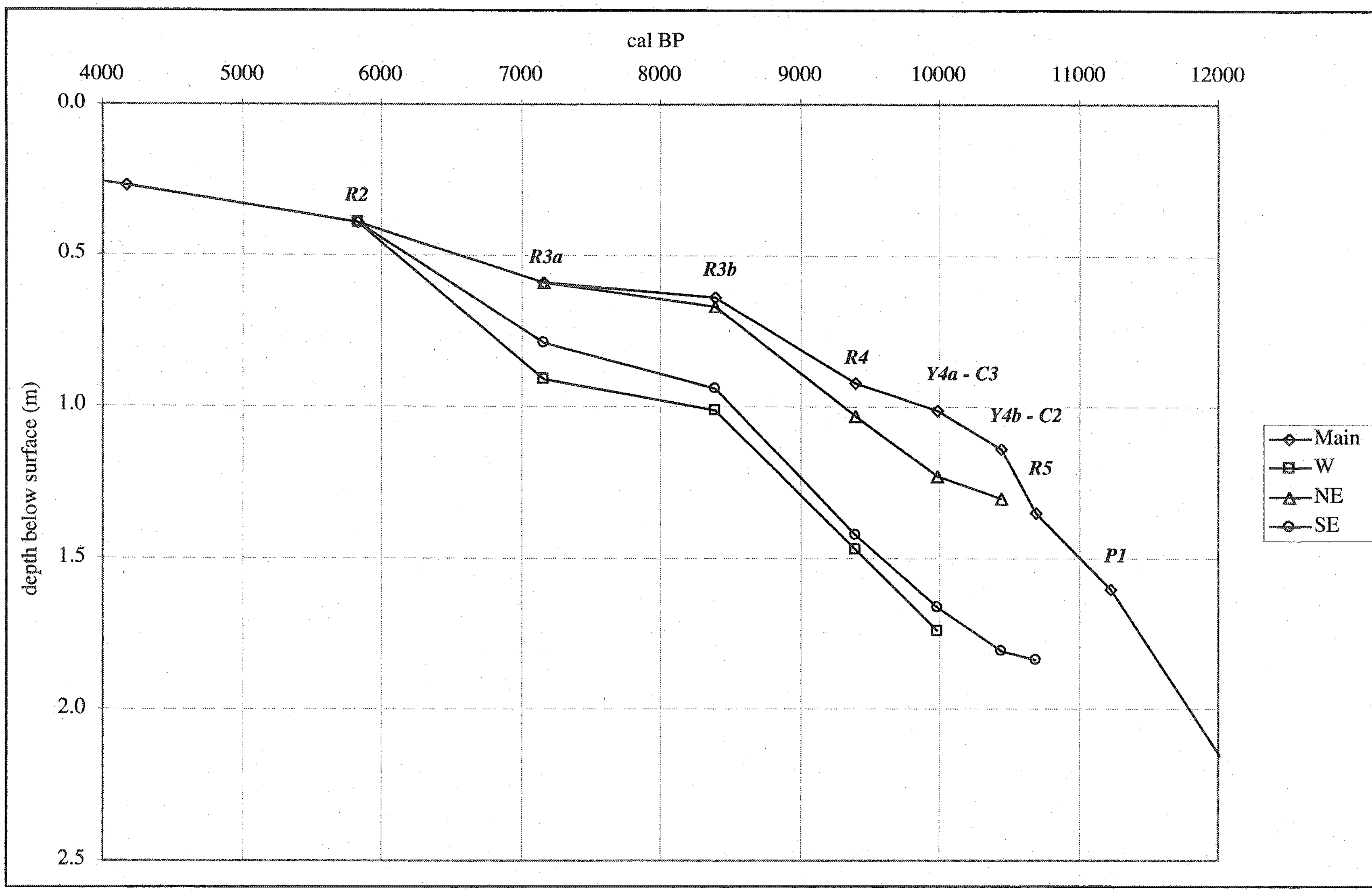

Figure 4.28 Lower Locus radiocarbon dates by depth by area.

Stratum Thickness Variability and Microtopography

Variability in stratum thickness was examined across the site in order to assess potential problems in component identification. Seventy-three points were used to generate thickness measurements, derived from stratigraphic profiles to minimize ambiguity. Stratum Y3 was measured from the bottom of the lowest R3 Bwb horizon to the top of R4, yielding 0.37±0.08 m (from 71 data points). Stratum R4 was 0.08±0.03 m thick (69 data points). Stratum Y4a was measured from the bottom of R4 to the top of R5, and was limited to where R5 was visible in the profiles. Stratum Y4a was 0.25±0.05 m thick (from 31 data points). Stratum Y4b was measured from the bottom of R5 to the S2 sand layer, and was 0.27±0.09 m thick (from 20 data points). The entire Y4 stratum was measured from the bottom of R4 to the top of the S2 sand layer, and was 0.50±0.09 m thick (from 37 data points). Sand 5 was 0.09±0.06 m thick. Stratum Y5 was measured from the bottom of Sand 5 to P1, and measured 0.20±0.07 m thick (from 15 data points). Coefficients of variation (standard deviation/mean x 100) for each stratum can be used to standardize the standard deviation

Because the standard deviation is not constant over the analytical range, coefficients of variation (CV) are used to assess variability in stratum thickness. CV ranged from 22-38% for all strata except Sand 5, which had a CV of 67%. This is due to the extreme variation of Sand 5 in the western portion of the site where it was expressed as three distinct layers and the main part of the site where it was expressed as one thin layer. The relatively low CV values for the other strata suggest no significant variations in stratum thickness.

Stratum microtopography was examined at the Lower Locus by means of line plots for stratum thickness from east to west and north to south across the site (Figures 4.29-4.30). For most strata at N48, a gradual compression (decreased thickness) occurs from E44 to N41, and an extension (increased thickness) occurs from E41-40, and a more gradual extension to the west of E40. Archaeological materials for Components 2 and 3 were found between E41 and E50, clearly relating to the more level surface in this area. The data for N50 and N52 are not as extensive, but similar patterns can be observed. Stratum Y4b is unusual among the strata in that it is compressed between E39 and E40 at N48 and E40 and E42 at N52. This may indicate a change in wind patterns or change in erosional processes during the period between 10000 and 9200 BP.

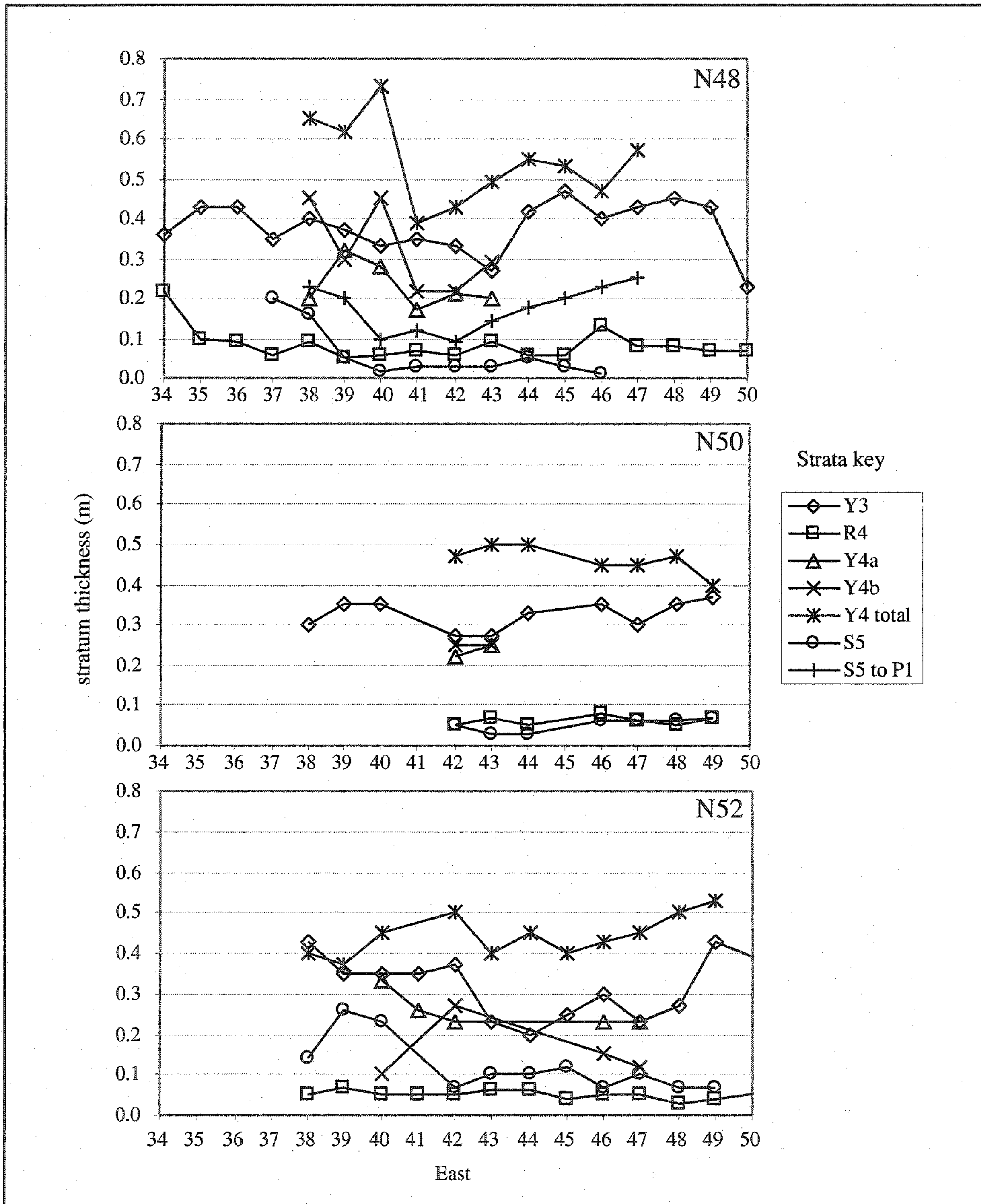

Figure 4.29 Strata thickness, east to west for N48, N50, and N52.

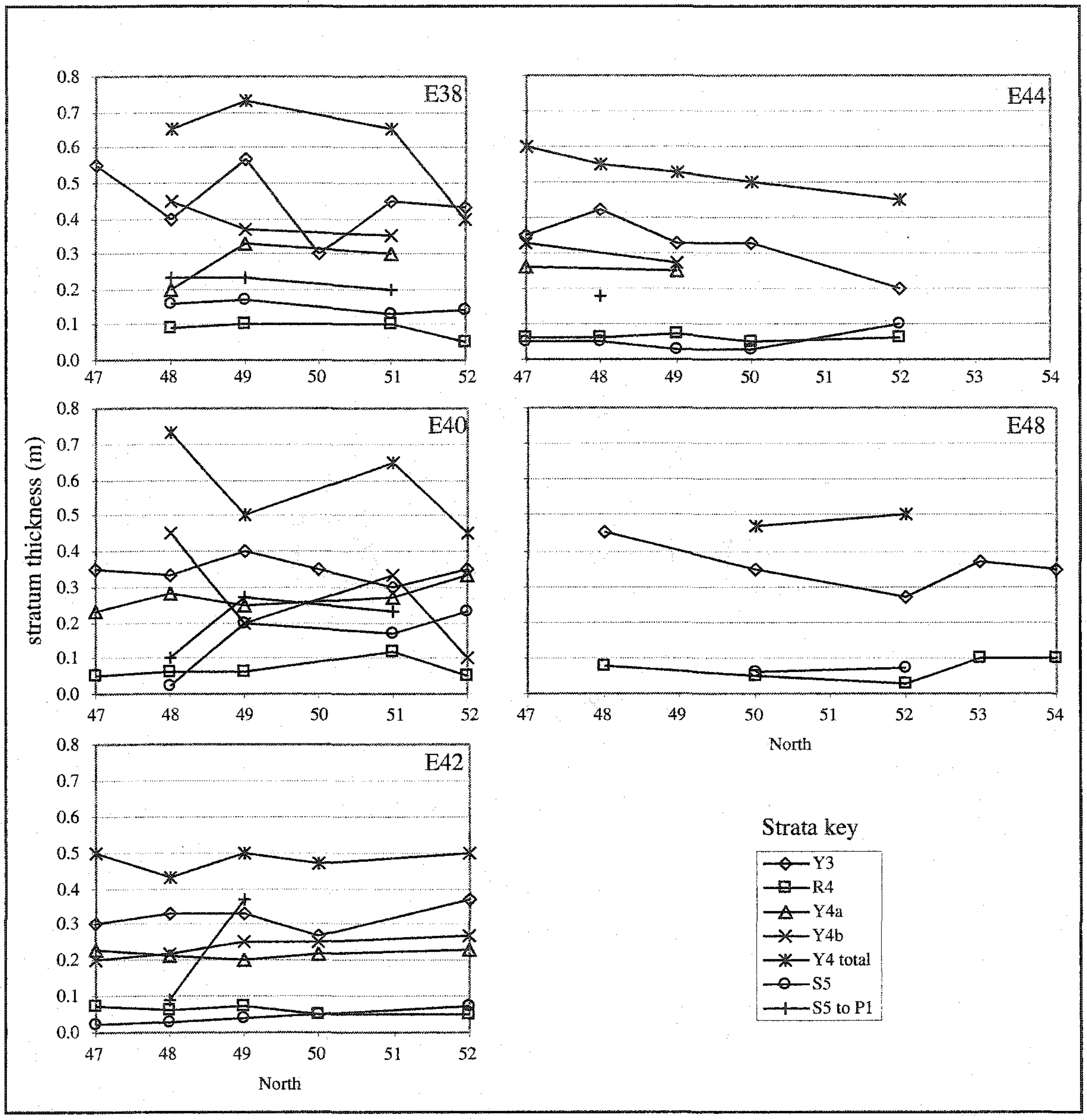

Figure 4.30 Strata thickness, north to south for E38, E40, E42, E44, and E48.

Stratum thickness variability along a north-south vector is more difficult to evaluate as only 7 linear meters could be profiled along any east-west transect (Figure 4.30). The overall patterning indicates extension from north to south, i.e., the strata become thicker along a gradient from north to south. This is especially clear at E44 and E48. The eastern profiles show a more subtle increase (at E38, E40, E42). This suggests that the lowest point in the saddle between the southern hill and the northern hill may be located at about N52, where most of the strata reach their minimum thickness values. The gradual slope suggests that the land surface of the site in the area now destroyed may have also been suitable for occupation. The portion of the site excavated so far may have only been a very small portion of the total occupation area, especially for Component 3 (see below).

Post-Depositional Disturbance

Given the high resolution this site may afford with respect to observed spatial integrity of cultural features, artifacts, and faunal remains, it is important to assess any potential distortion to this record. This section evaluates various post-depositional processes that may act to distort the stratification and integrity of artifact distributions. Machine scraping related to recent quarrying has removed some of the upper strata, but this is limited to strata above the cultural components, and the distribution of disturbed fill is mapped in detail (see above). Other post-depositional disturbance factors include microfaulting, cryoturbation, fossil animal burrows, and avian tunnels/nests at the eroding bluff edge.

A number of microfaults (slip faults) of limited dimension were observed in both loci. At the Upper Locus, these microfaults extend from Y2 to R4 and Y2 to Y3 on the A-grid north wall; R4-R5 on the C-grid east wall, Surface 2 to R3 on the G-grid east wall, R2-R4 on the Test Pit 1 east wall, and R3 to R4 on the Test Pit 3 east wall. Microfaults were rarer at the Lower Locus, only three were identified in the 95 linear meters of wall profiles (3% rate of occurrence). These were located in Block C (N50E38, north wall), Block T (N51E51, east wall), and Block R (N50E47, north wall). The dips were 73°, 62°, and 37° respectively, showing no pattern relative to site topography. These microfaults strike northeast-southwest, suggesting minor slumping following the southwest aspect of the site. All three microfaults were limited to between R2-Y2 in Block C, and R3 in Blocks T and R. This is similar to the more numerous microfaults at the

Upper Locus, where dip slip occurred above R4 and the major components at the site. The faults at the Lower Locus were between 3 and 11 cm, and in no case did they obfuscate strata delineation. These microfaults may have been caused by high intensity earthquakes or freeze-thaw action within the upper loess, but they do not appear to have been as common or extensive as those found at sites within the Nenana Valley, like Dry Creek (see Thorson and Hamilton 1977:15).

Some of the main factors in post-depositional disturbance in aeolian depositional environments in Alaska are cryoturbation processes (see Washburn 1980; Thorson and Hamilton 1977). Cryoturbation processes include formation of ice wedges and resulting sand wedge casts, frost polygons, solifluction deformation (due to active layer movements), drag structures, and solifluction lobes. Very little evidence of cryoturbation was found at Gerstle River Lower Locus. The strata were generally horizontal, with no evidence of severe deformation. The paleosols showed no evidence of overturned folds. No ice wedges, sand wedges, frost hummocks, or solifluction lobes were observed.

Fossil animal burrows (krotovinas), marked by discrete casts infilled with a matrix different in color and texture with the associated strata, were observed at the Lower Locus. These casts were between 5-15 cm in diameter, roughly circular, and limited exclusively to Units IV, V, and VIa. No organic matter was found within these krotovinas. These fossil burrows can be seen in Figures 4.14-4.16. Those krotovinas within Unit IV and V (gray sand) were infilled with Unit VIa brown sand or a mixture of brown and gray sand. Krotovinas within Unit VIa (brown sand) were infilled with gray sand. While one krotovina was noted within Y5 (Unit VII) at the Bluff Test Pit (Holmes 1998a) (Figure B.2), no krotovinas were present within the Lower Locus excavation above Unit VIa, one meter or more below the lowest component. This limited vertical distribution (~20 cm) suggests formation of these burrows between 12000 and 11000 BP. Guthrie (1985) noted that ground squirrels were in the Tanana Lowlands region during the full glacial, but some ground squirrels were found in association with Cultural Zone 3 materials at Broken Mammoth, dating to ~10300 BP (Yesner 1994).

Small birds have used the eroding bluff edge to excavate tunnels and nests after the destruction of the southern hill in 1995. These tunnels were generally less than one meter from the southern edge of the bluff. The birds preferred the eroding loess edge (within stratum Y3) rather than the excavated vertical walls. However, one area they did infiltrate was the north wall of Block G, where sediment samples were excavated in 1999. They enlarged some of these holes above R4. During the course of excavation, several of these tunnels/nests were encountered. These tunnels were all mapped, but none affected the distributions of artifacts or stratigraphic delineation.

Spatial Integrity

While potential disturbance factors described above do not appear to have affected spatial integrity of the component materials, the location of components within massive aeolian loess depositional environments without discrete occupation surfaces suggests the need for evaluation of various measures of integrity. These include data on lithic artifacts, such as orientation (flat, oblique, or vertical), weathering of ventral surfaces, size sorting of lithics, and evidence of elongation of lithic concentrations due to colluvial movement downslope. Data on faunal remains pertinent to evaluating spatial integrity include orientation, size sorting, linear concentrations, and weathering patterns. Composition of the cultural material also can be used to evaluate the level of post-depositional disturbance. The vertical and spatial relationships among large and small chipped stone pieces, large cobbles, large articulated bone fragments, tiny calcined bone concentrations, and thin light charcoal fragments are evaluated.

Vertical distributions of artifacts are examined not only in order to evaluate overall spatial integrity at the level of component but also to assess small-scale perturbations at the level of occupation (see Chapters 5-6, 10). Peakedness of the vertical distributions is examined for unimodality, bimodality, or randomness. Other variables include cultural deposit thickness, morphology of the distributions, and vertical variation.

Lithic orientation was not systematically recorded after the initial description of flake scatters in 1999 (see Figure 4.31). Well over 90% were flat, and the rare specimens that were oblique or vertical was generally noted as such in field books or level sheets. All large lithic artifacts were horizontal or nearly horizontal. Ventral surfaces of lithic artifacts are not differentially weathered, indicating that they were not on the surface for a long period. Of the 8403 flakes in Components 1, 2, and 3, 99.1% have no edge damage. Of the 1452 microblades in Components 2 and 3, 89.9% have no edge damage. Between 8-52% flakes of each material type in these components are complete (see Chapter 8), and the wide variability suggests little post-

Figure 4.31 Lithic scatter in Block B in 1999 showing horizontal microblades and flakes, view grid south.

depositional breakage. These data strongly suggests a lack of post-depositional disturbance (including trampling) as well as lack of extensive reoccupation.

No size sorting of lithics was observed in any of the components. Figures 4.32 and 4.33 show size class density plots for unmodified flakes and microblades in Component 3 and unmodified flakes in Component 1. No size-sorting surface trends including elongation based on site topography was observed in Component 3. For Component 1, while no size sorting was observed based on these size classes, possible elongation northeast-southwest (following the aspect of the hill slope) may reflect horizontal displacement, perhaps due to colluvial transport. Components 2, 4, and 5 materials were limited in frequency and spatial distribution, so are not assessed here. Generally, they are similar to Component 3 in lack of size sorting or formation of linear concentrations suggestive of colluvial or fluvial displacement.

No size sorting of faunal remains was observed within Component 3. Figures 6.10-6.15 illustrate faunal remains larger than 4 cm in maximum dimension and density isopleths of all faunal remains regardless of size. No linear arrangements of fauna were noted. The distribution of faunal remains suggests very little post-depositional taphonomic disturbance. The orientation

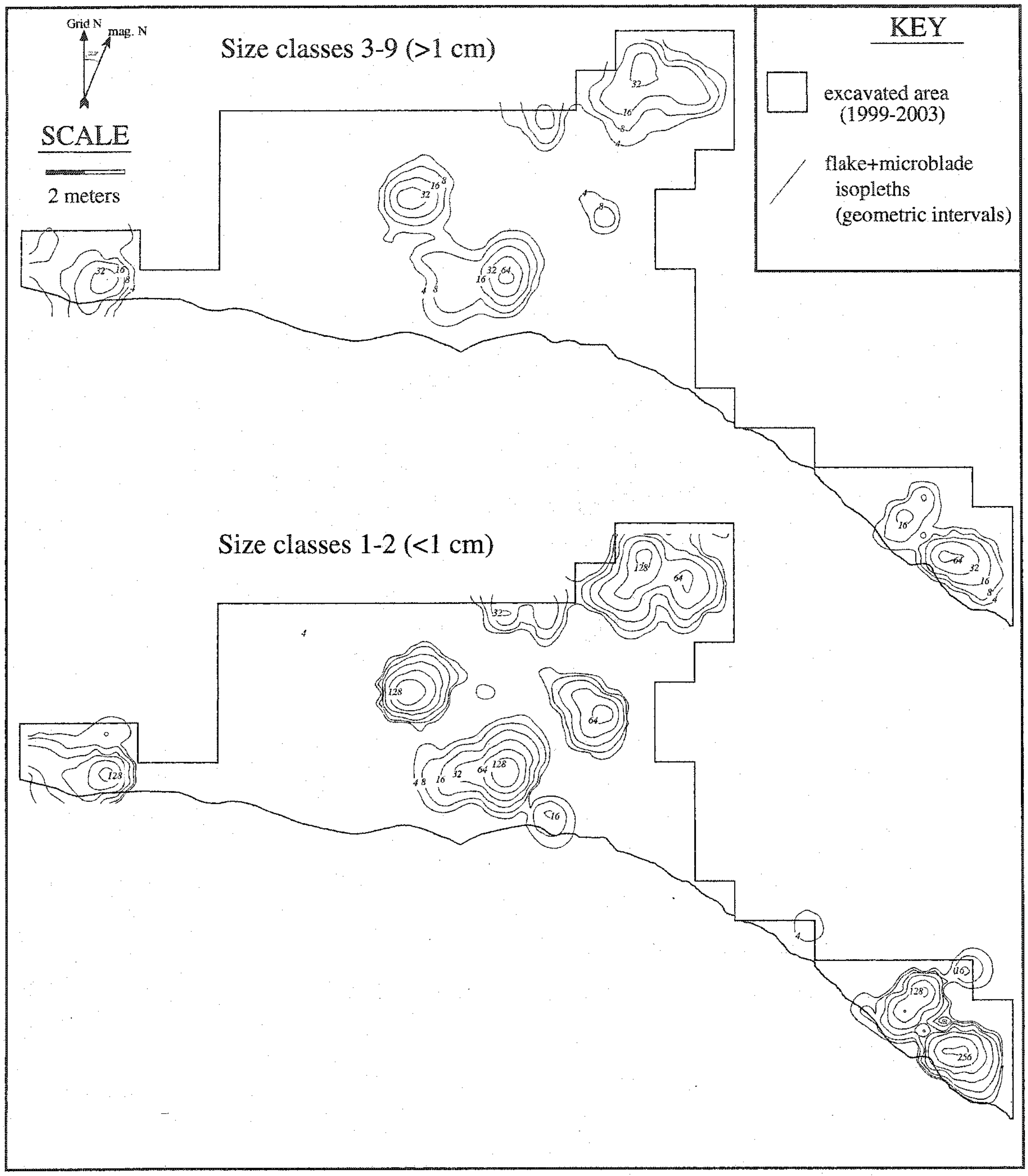

Figure 4.32 Component 3 unmodified flake and microblade size class distributions (n=6,796).

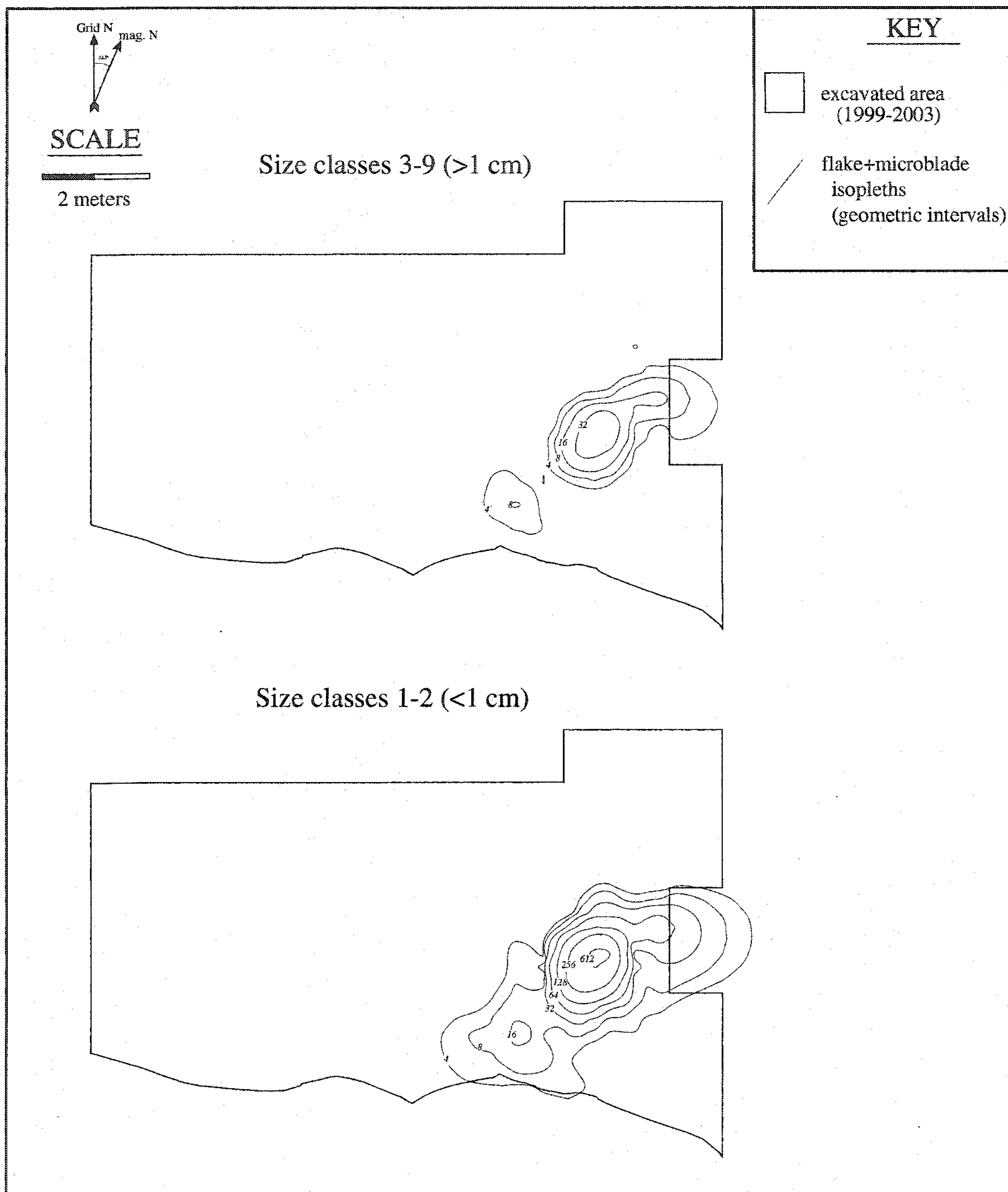

Figure 4.33 Component 1 unmodified flake size class distributions (n=2,034).

of all large faunal remains was horizontal (see photographs of *in situ* faunal remains in Chapters 6 and 9). Extended occupations or occupations separated by enough time may have altered the weathering patterns and conditions of the faunal remains, however weathering was relatively consistent across Component 3.

The vertical distribution of artifacts through the sediment column also demonstrates the spatial integrity of the components at Gerstle River. Of the nine major lithostratigraphic units, cultural remains are found only within two (VII and IX). Of the 23 sub-units, only four have cultural remains, Y5 (Component 1), Y4b (Component 2), Y4a (Components 3 and 4), and Y3b (Component 5). All of these components have discrete stratigraphic boundaries between them (except Components 3 and 4), such as sand layers or Bwb horizons.

Small-scale perturbations in sediment accumulation or post-depositional movement of artifacts within components can be identified through examination of vertical profile back plots. The three-dimensional plotting of artifacts from all components at the Lower Locus and plots of artifacts at the Upper Locus indicate unimodal distributions with little vertical variation. Figure 4.34 shows the locations of the vertical profile back plots illustrated in Figures 4.35-4.43. Separate symbols are used for lithic items, mapped faunal fragments, and cobbles. Bottom elevations of large faunal fragments and cobbles were used to construct these plots. The vertical profile back plots illustrate vertical positions of all materials in east-west and north-south transects of 50 cm in dimension (i.e., all items within E42.0 to N42.5 would be illustrated in the first transect in Figure 4.35). However, it should be noted, that due to the gradual slope to the southwest, the distributions are more vertically concentrated than they appear in the plots.

Figure 4.35, a north-south profile in the main area from E42-45 shows the clear separation of Components 1, 2, 3, and 4 and the gradual slope to the south. Component 1 in this area shows a tight vertical distribution, similar to that of Components 2 and 3. Figure 4.36, a north south profile from E45-48 shows continued tight vertical clustering of Component 3, but the Component 1 distribution exhibits a change in vertical thickness, a relatively tight ~10 cm thick spread north of N48.5 and a gradual vertical spreading of cultural materials south of N48.5, to an extreme of ~40 cm. This is especially evident at the E47-47.5 and E47.5-48 transects. N48.5 marks a pronounced dip to the south in strata, reflected in the distributions of Component 1 and Component 3 materials. However, Component 3 materials are still tightly constrained vertically, whereas Component 1 materials show evidence of displacement. This may indicate that the colluvial disturbance (Feature 6) within stratum Y5 acted to displace the artifacts to the south.

Figure 4.37 continues the north-south profile back plot to the east, reaching the eastern edge of Component 1 materials. Component 3 artifacts in the northeastern area of the site do show some possible bimodality (see E50-50.5), but the majority of the remains in this area show a tight vertical distribution.

Figure 4.38, an east-west profile in the main area from N45-48 shows the clear vertical separation of the components and the tight vertical distribution of Component 3. Component 1 shows a much wider vertical spread. Two components could have been identified in transects N47-47.5 and N47.5-48, however the materials consisted of only one main material type (87% by number, 72% by weight), and the best explanation is displacement through colluvial disturbance (see above). Support for this hypothesis is found in the distribution of Component 1 shown in Figure 4.39, transects N48-N49.5. While Component 1 material west of E46 show tight vertical clustering, the material to the east of E46 exhibit a bulge in vertical distribution suggesting slope wash may have displaced the artifacts along a northeast-southwest trajectory, following the slope of the site. Based on the morphology of the overall vertical distributions for Component 1, it appears as if the disturbance acted to push artifacts deeper in the sediments, as the majority of artifacts still reflect a relatively tight surface. This downward displacement is relatively localized to an area about 1.5 m wide in these transects, though a few artifacts are found to the east of these "bulges."

Figure 4.40 shows the east-west distribution for the northeast area of the site. For most transects, a clear unimodal distribution is evident for Component 3, though in N53.5-54, a number of items are found about 5-10 cm below the main group. This group can be seen in Figure 4.34, E49-49.5 transect. This may reflect an earlier occupation in this area (Area C, near Feature 18), but the majority of the artifacts and faunal remains in the area show a tight unimodal vertical distribution.

Figure 4.41 shows the north south distribution in the southeastern area (Blocks Y and AA). The clear separation of Components 2, 3, 4, and 5 are evident. Note that Component 4 materials in E55.5-56 transect are clearly separated from Component 3. This separation is not so clear in the east-west distribution (Figure 4.42, N40.5-41 transect), but this is due to the aspect and slope (north-south) in this area.

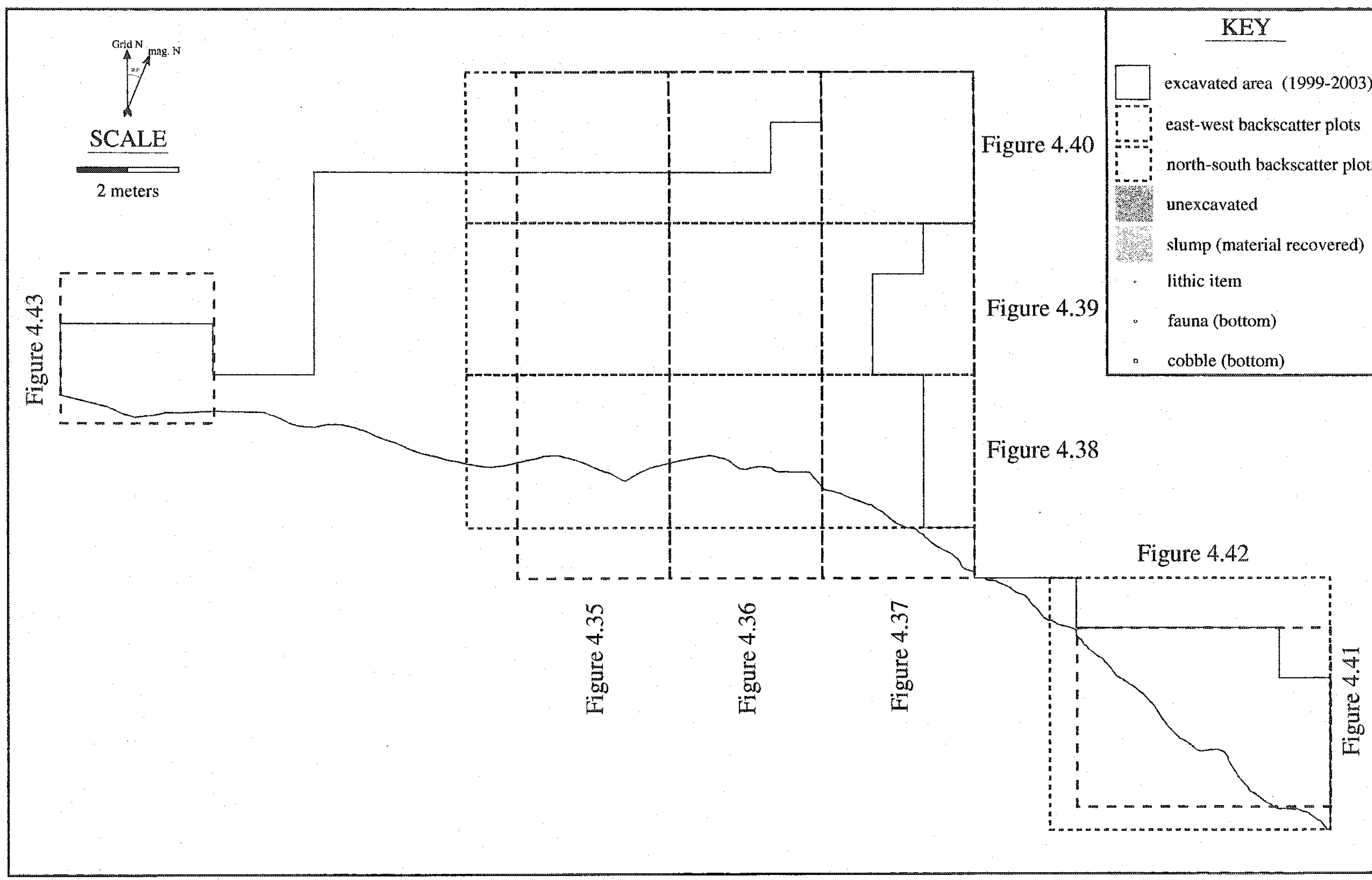

Figure 4.34 Location and key for vertical profile back plots, Figures 4.35-4.43.

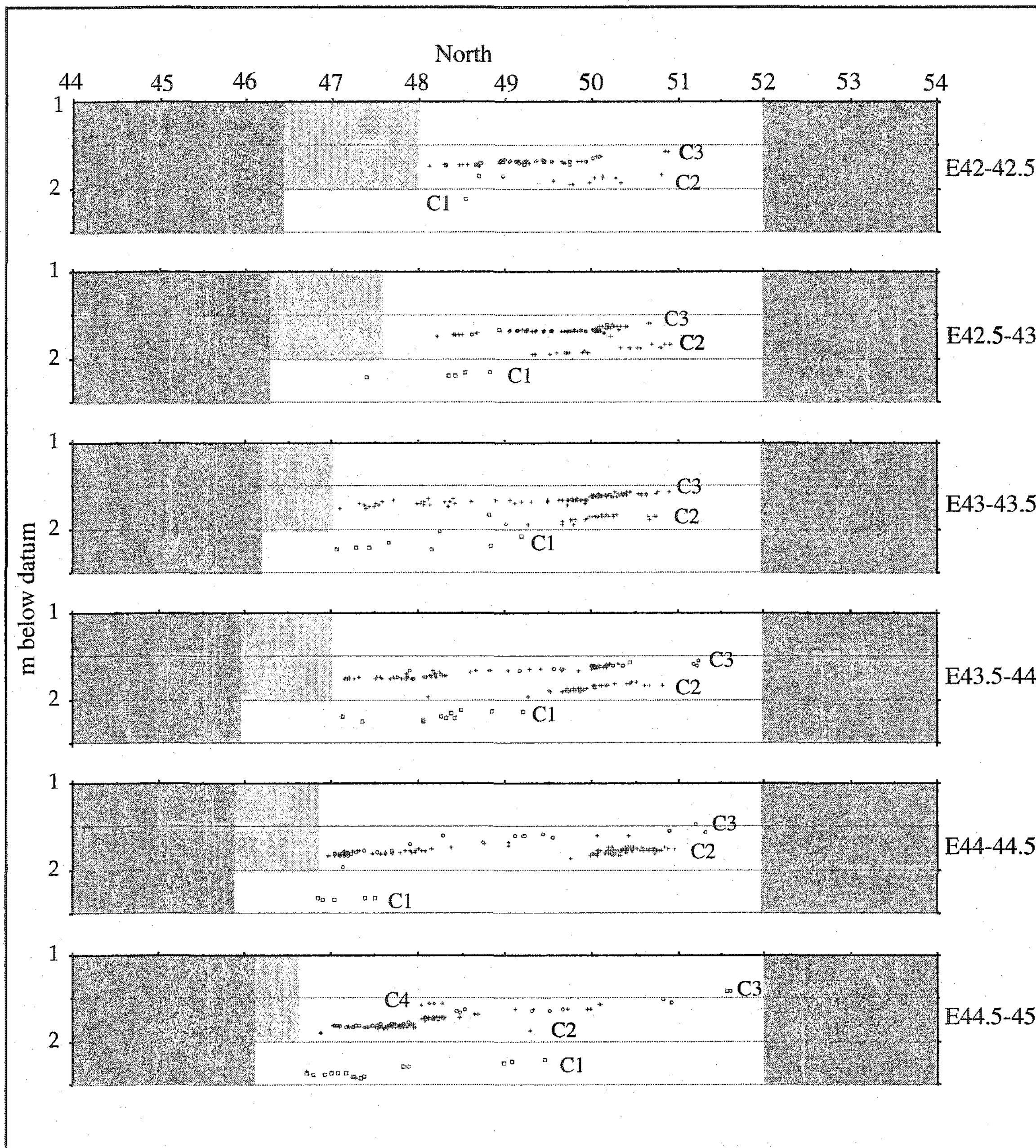

Figure 4.35 Main area north-south vertical profile back plot, E42-45.

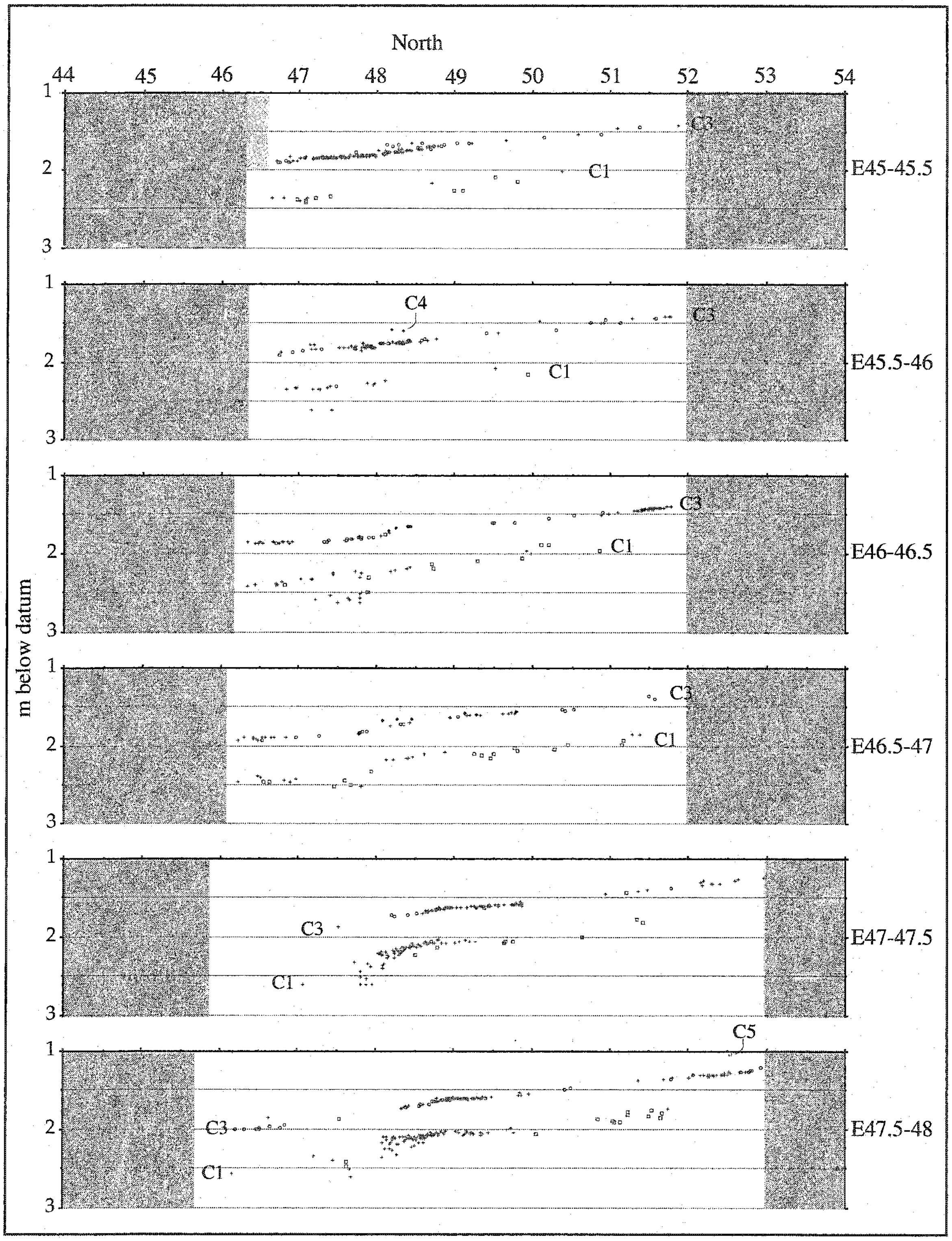

Figure 4.36 Main area north-south vertical profile back plot, E45-48.

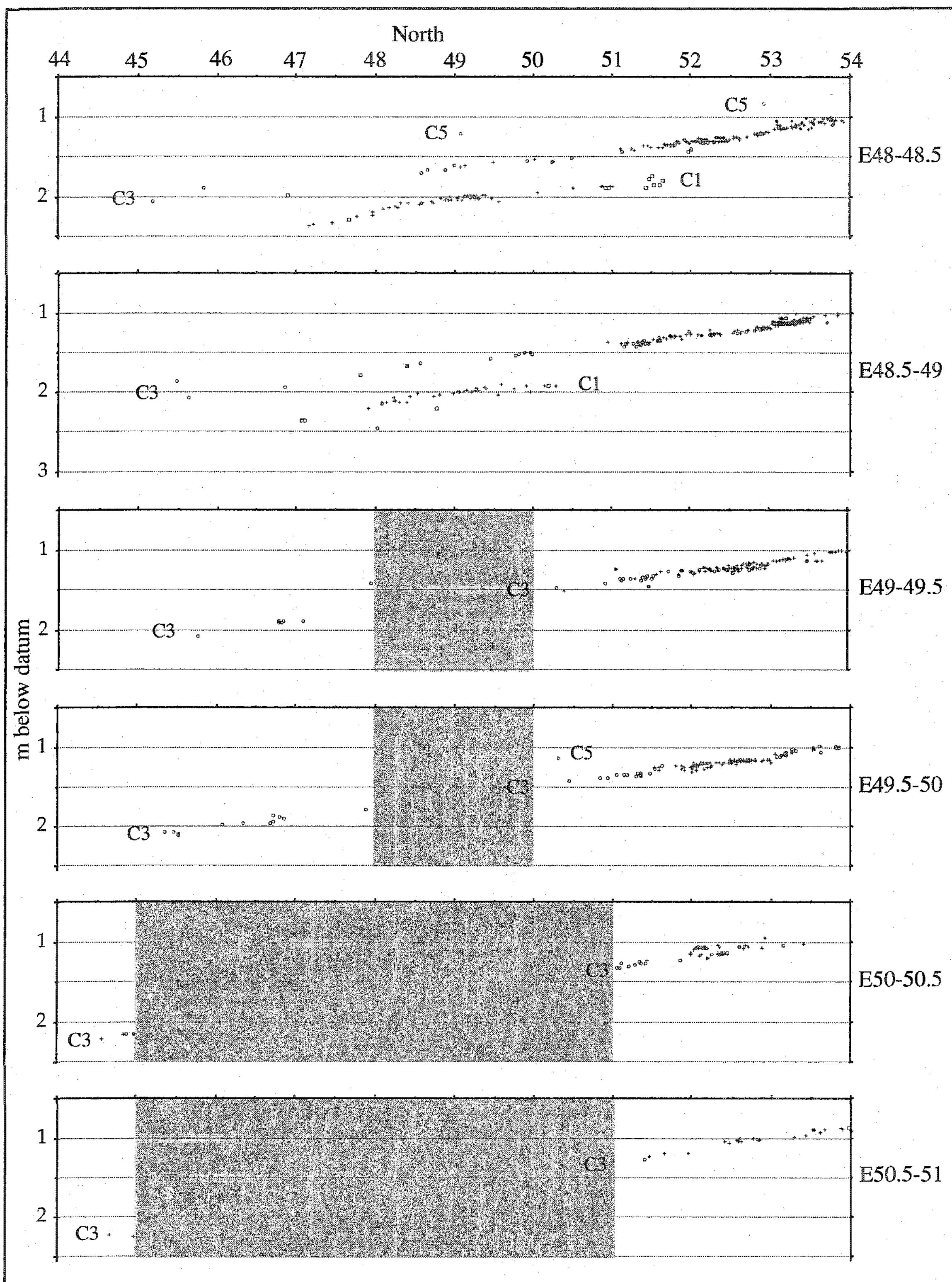

Figure 4.37 Main area north-south vertical profile back plot, E48-51.

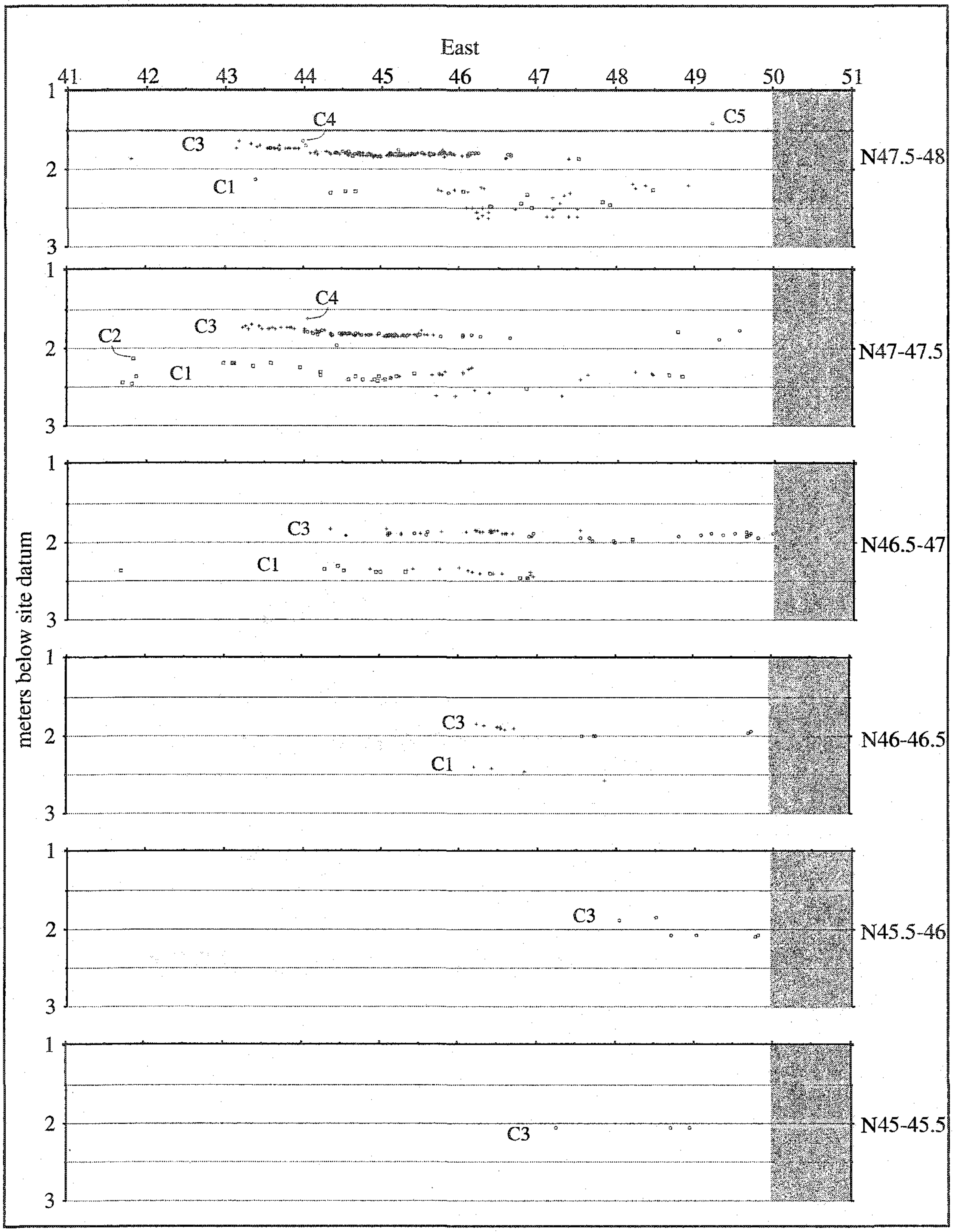

Figure 4.38 Main area east-west vertical profile back plot, N45-48.

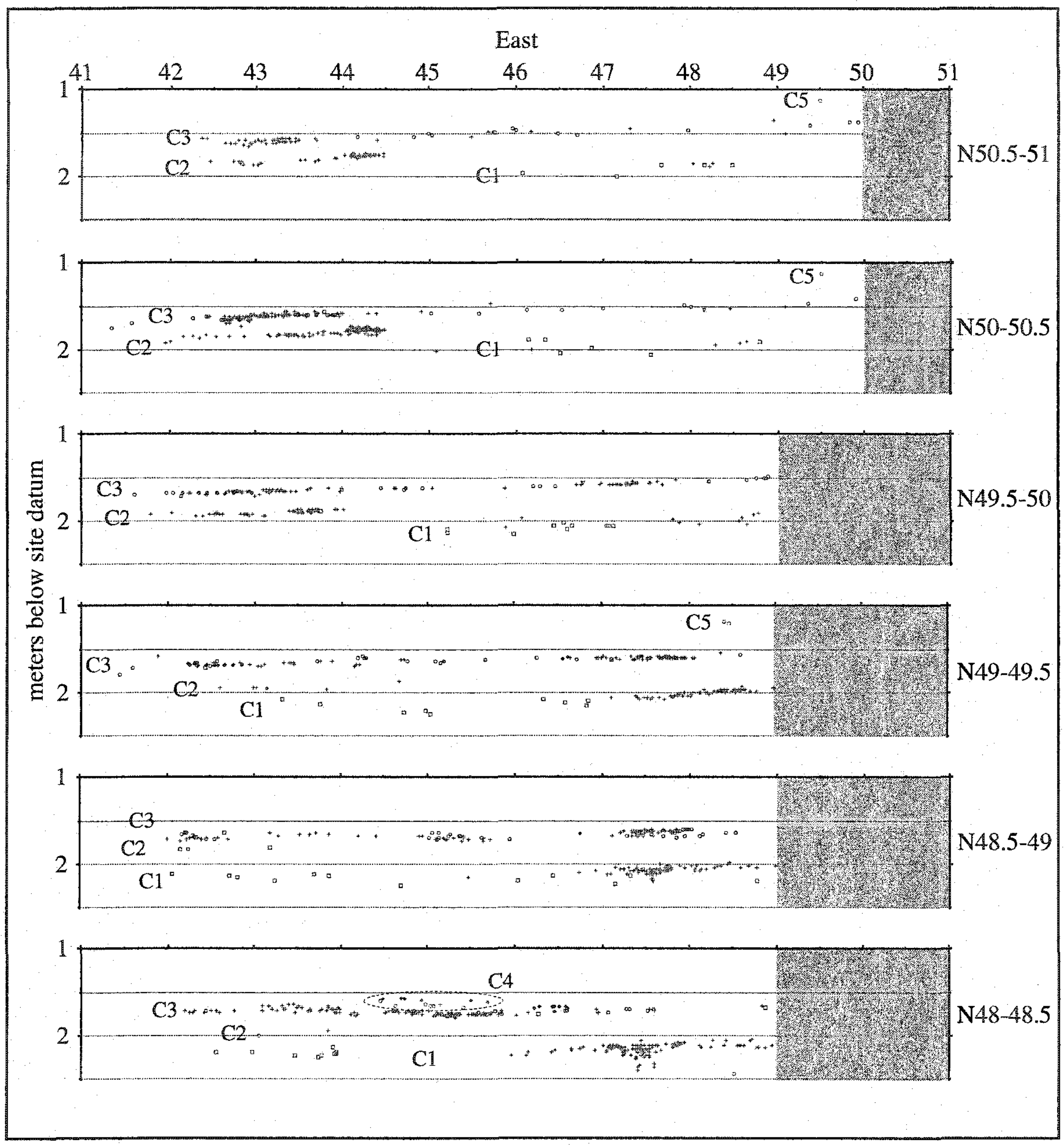

Figure 4.39 Main area east-west vertical profile back plot, N48-51.

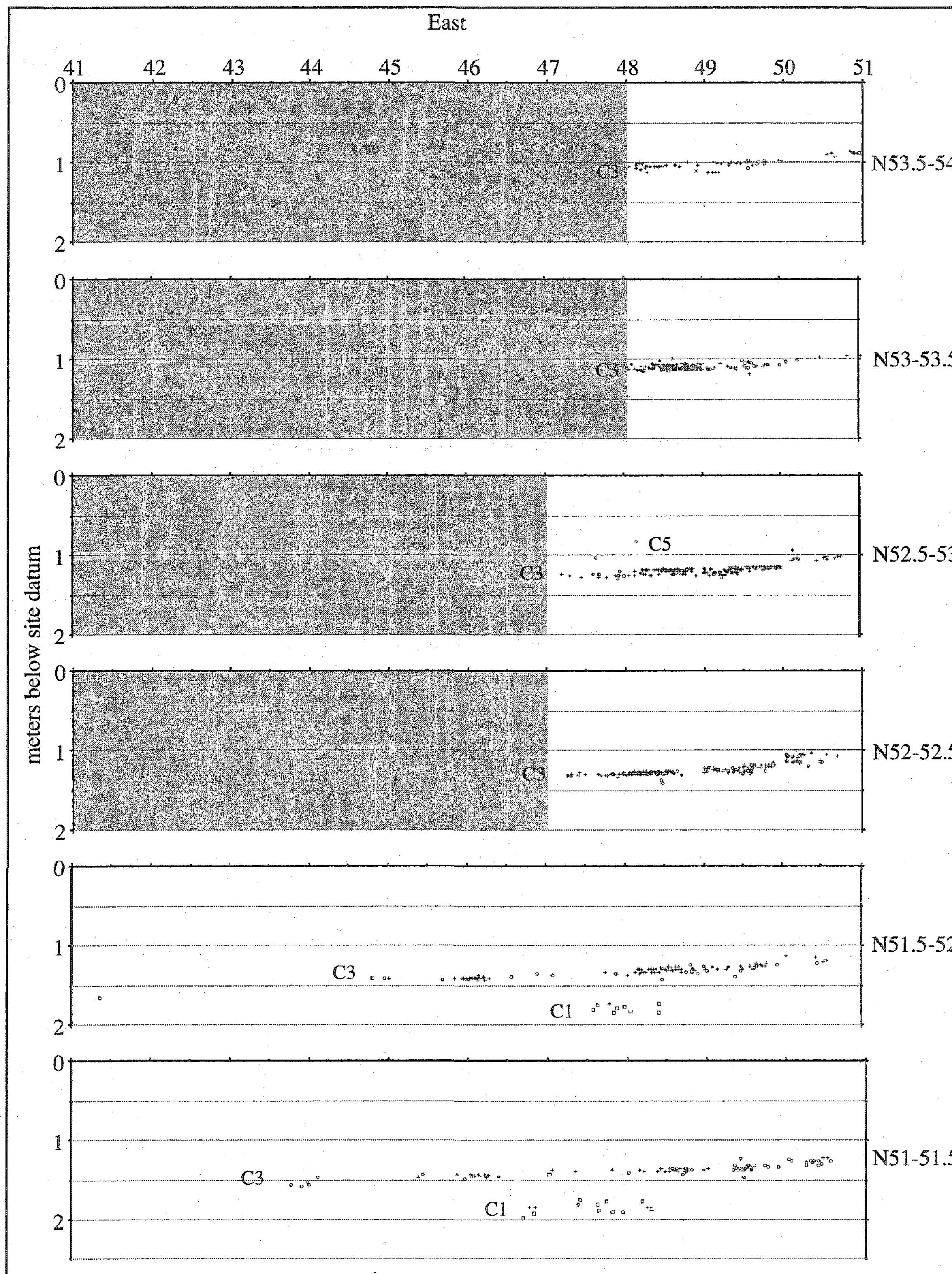

Figure 4.40 Main area east-west vertical profile back plot, N51-54.

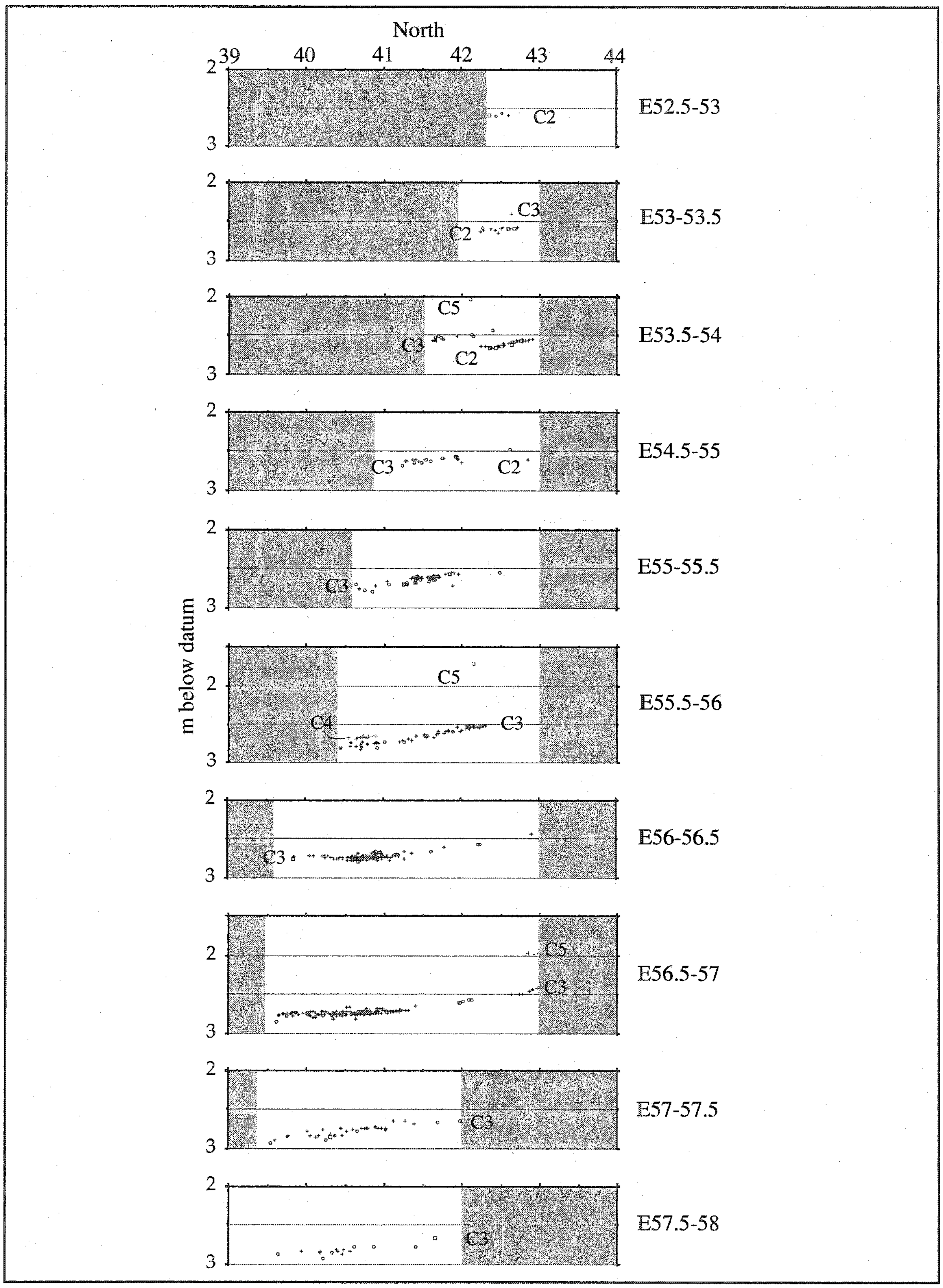

Figure 4.41 Southeastern area north-south vertical profile back plot, E52-58.

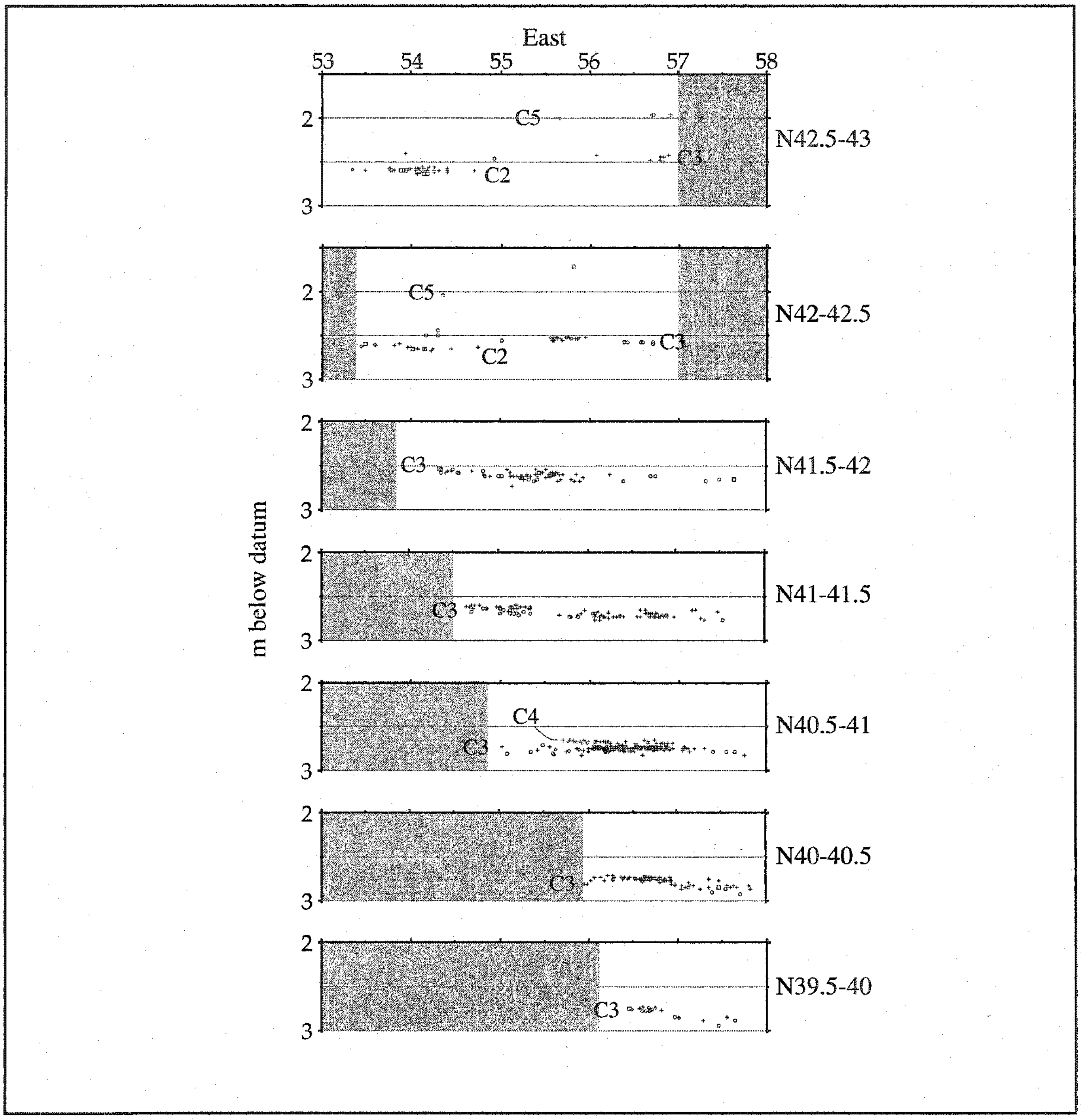

Figure 4.42 Southeastern area east-west vertical profile back plot, N39.5-43.

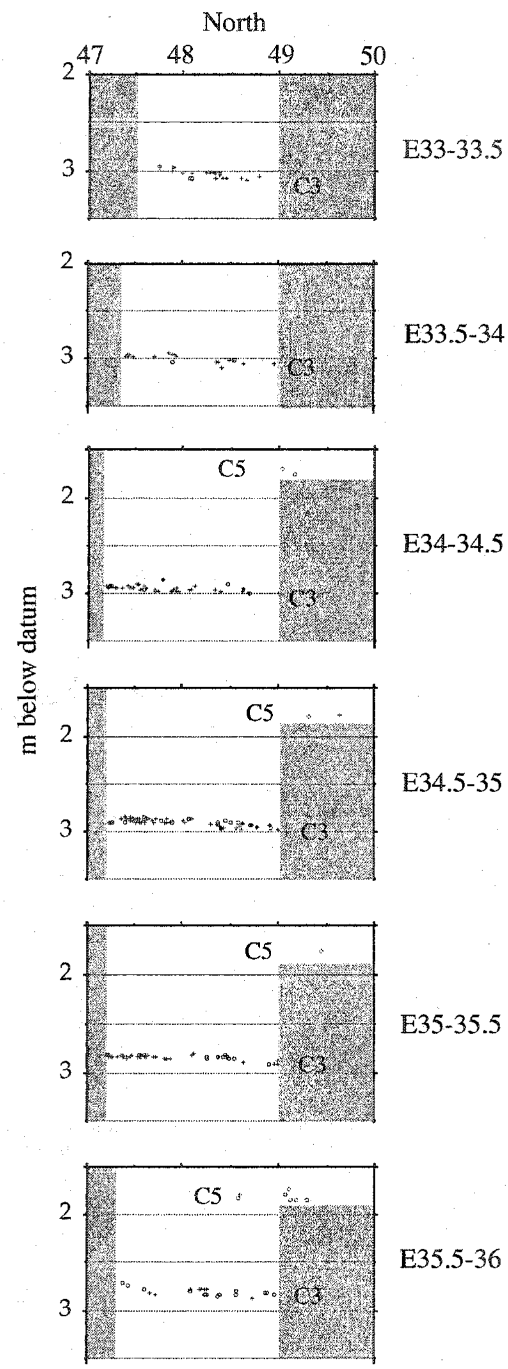

Figure 4.43 Western area north-south vertical profile back plot, E33-36.

Figure 4.43 shows the north-south distribution in the western area (Block V). A unimodal distribution for Component 3 is evident.

Spatial clustering of lithics and faunal remains in Component 3 suggest the presence of a "living floor," that is a spatially integrated depositional set. The varied composition of the artifacts (e.g., large, small, and tiny chipped stone tools and fragments, large cobble manuports, large articulated faunal remains, and small calcined bone fragments) also suggests contemporaneity with little post-depositional disturbance. Tiny, light charcoal fragments and heavy bones and teeth are found in close spatial proximity (see Chapter 6 and 9). The absence of refits between components also supports spatial integrity. There is little evidence of partial mixing of what may have been discrete occupations originally. Feature discreteness is moderate to high (see Chapter 9). The radiocarbon chronology among components and intervening strata suggest that these materials are preserved at a high level of resolution (see Chapter 5).

Vertical distributions of all components are unimodal and thin, generally between 2-10 cm for Components 2, 3, and 4. Component 1 has a wider vertical distribution (~13-40 cm), especially south of N48.50 (see above), which may relate to localized downward displacement by a colluvial event after deposition. Gerstle River sediments were deposited in relatively low energy environments after 10000 BP. Vertically thin concentrations of artifacts spread over a wide horizontal area indicate that they were deposited on a stable surface. The cultural materials seem to reflect different activities at the site. In sum, the data described above indicate very strongly that Components 2 through 5 were subjected to very little post-depositional disturbance. Component 1 does seem to have some disturbance, likely due to a colluvial slope wash event around the same time as the occupation. However, given the limited range of material types in Component 1 and formal tools, a short, single occupation is a reasonable interpretation.

Provisional Model of Site Formation

Based on the data presented above, a provisional model of site formation is described for the Lower Locus. Local *in situ* weathering of granodiorite bedrock (Unit I) resulted in patches of degrading bedrock (Unit II) and coarse gray grus (Unit III). One or more deflationary periods corresponding to glacials probably removed sediments at the site, scoured the bedrock, and formed ventifacts. The terminal moraines of the Delta Glaciation and Donnelly I glaciation

(25300 – 14800 BP[1]) were only 3 and 4 km south of the site respectively. Sometime prior to 12000 BP, a colluvial event resulted in the redeposition of ventifacts and gray sand from the slope above the Lower Locus forming Units IV and V.

Sometime after 12000 BP, an erosional environment gave way to a depositional environment, lasting 2000 radiocarbon years. The primary aeolian sediment was sand with a minor silt/clay component, suggesting a very active environment. Sand dunes formed a few kilometers to the northwest of the site at the northern end of the Gerstle River outwash apron (Hamilton 1973). This aeolian sand deposition (Unit VI) apparently did not allow stable surfaces to form at the Lower Locus, though horizontal bedding indicates relatively even distributions. No paleosols or other soil horizon remnants were found in this sand.

An amelioration of the environment, or increased vegetation at the site around 10000 BP resulted in the formation of the first remnant stable surface of the Holocene at this site (Unit VII). At least two pedogenic events occurred around 10000 BP (Paleosols 1 and 2). The first occupation of the site occurred with the later soil-forming period, or closely thereafter. The paleosols are well developed at the western portion of the Lower Locus. In Block D, a Component 1 flake was located 3 cm above Paleosol 1. The paleosols weaken further to the east, and a colluvial slope wash appears to have occurred after their formation. Given the distribution of cultural materials and colluvium, the slope wash event(s) likely occurred after the Component 1 occupation.

Aeolian sediments from 10000 BP onward were characterized with finer particles except for a brief period of more active conditions resulting in the deposition of a number of sand layers (Unit VIII), until around 8400 BP, when silt became the predominant particle size.

Between 9900 and 9450 BP, intermittent increased wind effectiveness led to aeolian deposition of a number of sand layers (Unit VIII, Sand 5). The last period of sand deposition gradually included more loess (Unit IX). The second occupation at the site (Component 2) occurred during loess deposition in stratum Y4b. No paleosols occur in this stratum, suggesting a relatively active environment with little vegetative cover.

The deposition of stratum Y4b was followed closely by the development of another stabilized surface (R5), dating to around 9300 BP. Differences in structure and lack of a prominent Abk horizon indicate that a poplar forest may have developed during this period.

[1] All dates in this model are given as radiocarbon years before present (BP).

The main occupation at the site (Component 3) and a localized re-occupation (Component 4) occurred during loess deposition between 9100 and 8700 BP. As with Y4b, no paleosols occurred within this matrix (stratum Y4a). The presence of numerous well preserved faunal remains suggests rapid burial by loess.

A few hundred radiocarbon years after the Component 4 occupation, the occurrence of spruce forests is documented by a well-developed Abk and Bwb horizon at 8300 BP (R4). From this period throughout the remainder of the Holocene, the presence of numerous Abk and Bwb horizons interbedded with massive loess suggest cyclic forest soil development and forest fires. Sedimentation rates decreased for the later Holocene, suggesting spruce forests covering much of the surrounding areas. The R4 horizon is capped by a very well developed Abk horizon, with burned and unburned organics up to 3 cm thick. This suggests a long period of soil development followed by a rapid burial by increasing loess deposition. None of the other Bwb horizons possess such a strong Abk horizon, except perhaps for R2, which was well developed in Block V in the western part of the site.

The Lower Locus was reoccupied for a final time around 8000 BP, during a period of loess accumulation and development of immature soils (thin Abk horizons lacking a B horizon). The modern soil (apparently formed by the white spruce forest found at the Lower Locus until the 1960s) developed by at least 3800 BP, interrupted by a tephra fall sometime in the late Holocene. The last occupation at the Upper Locus (Component 7) occurred during the last period of loess deposition (stratum Y1). Consistently, the occupations at Gerstle River seem to be associated with loess deposition rather than soil formation episodes. This may relate to site and surrounding area vegetation characteristics and observation potential from the site.

The well stratified and dated sequence at Gerstle River can be broadly compared with other Tanana and Nenana valley sites. Several sites in the Tanana and Nenana valleys exhibit the following sequence of the lowest two paleosol complexes, the lowest generally dating to about 10500 to 10000 BP (found at Gerstle River, Broken Mammoth, Mead, Swan Point, Dry Creek, Moose Creek, and Panguingue Creek), and the next lowest dating to about 9000 to 8000 BP (found at Gerstle River, Delta River Overlook, Hurricane Bluff, Dry Creek, Walker Road, and Panguingue Creek).

The nearest well stratified sites to Gerstle River are Broken Mammoth and Mead. Stratigraphic data for these sites are provided by Dilley (1998:78-140); Holmes (1996); and Holmes (2004, personal communication). Broken Mammoth and Mead sites have comparable stratigraphy, and a number of correlations can be made at a regional scale with these sites and Gerstle River. The two lowest paleosol complexes are dated to between 11770-11040 BP and 10460-9310 BP. The upper paleosol (Middle Paleosol Complex Unit 3B) may be broadly correlated with Paleosol 1 at Gerstle River (10000 BP). The Upper Paleosol Complex (Unit 3C) at Broken Mammoth is undated (but between 9130 and 7700 BP), but may correlate with the pedogenesis associated with stratum R4 at Gerstle River (~8300 BP). A sand unit (Upper Sand Unit 4) is present at Broken Mammoth between 9310-7700 BP (Dilley 1998) that may correlate with Sand 5 (Unit VIII) at Gerstle River, dated to between 9130-9400 BP. The tighter bracketing dates at Gerstle River may provide more precise chronological control on this aeolian sand deposition episode. Thus, while the period between 12000 and 10000 BP appears to be very different at Gerstle River than at Broken Mammoth and Mead, the episodic periods of soil formation and loess deposition between 10000 BP and 8300 BP may be broadly similar. The detailed sequence of forest soil development and episodic burning preserved at the Gerstle River site between 8300 and 3800 BP is not present at the Broken Mammoth and Mead sites. Swan Point stratigraphic data show no clear correlations other than the 10230 BP paleosol complex within Unit 4 (Dilley 1998:141-164), which may be associated with soil forming episode as Paleosol 1 at Gerstle River.

Delta River Overlook (XMH-297), located on a bluff edge overlooking the Delta River, has a detailed sequence of well preserved forest soils interbedded in massive sand and silt (Leehan 1981; Bacon and Holmes 1980; Holmes 1979). The lowest soil complex at this site is dated to between 8560 and 7190 BP, and may be comparable to the lowest well developed forest soil at Gerstle River (R4, 8300 BP). A number of the other Bw horizons at Delta River Overlook may be comparable to periods of soil formation at Gerstle River, P2, dated to 6680 BP may correlate with stratum R3 (6200-7600 BP) an undated paleosol (between 6680 and 3980 BP) may correlate with stratum R2 (5050 BP), and P4, dated to 3980 BP may correlate with stratum R1 (upper limiting date of 4120 BP). The upper sequence at Delta River Overlook is very different, with a deep series of aeolian sands deposited after 2280 BP (Leehan 1981:34). Hurricane Bluff, located ~200 m southwest of Delta River Overlook has a date of 8810 BP on the lowest forest soil (Higgs et al. 1999). Such a broad occurrence of pedogenesis to the period between 8810-8300 BP suggests a widespread amelioration of climatic conditions or increased vegetation, probably related to the growth of the spruce forest in the Tanana valley (Ager and Brubaker 1985).

While the Nenana River valley is located about 120 km to the west, the pattern of paleosol formation is roughly comparable to Tanana Valley sites (Dilley 1998:234-247). The pattern of paleosol formation at Dry Creek (Thorson and Hamilton 1977), dated at 10600-10000 BP, 9700-9300 BP, 8400 BP, and 6300 BP, roughly corresponds to those at Gerstle River, 10000 BP (P1), 9300 BP (R5), 8400 BP (R4), and 6300 BP (R3a). Sand 1 (11100-10000 BP) underlying the oldest paleosol complex may be correlated with windier conditions during the Younger Dryas, and may be correlated with Sand 5 at Gerstle River. The widespread occurrence of soil formation periods around 10000 BP and 8500 BP is interesting, and could be signals of regional climatic and vegetation change.

CHAPTER 5. RADIOCARBON DATING

Introduction

This chapter describes the results of chronometric and relative dating strategies with respect to site chronology, activity area contemporaneity, and site occupations. Along with an extensive radiocarbon dating program, sediment influx rates, taphonomic, and other data are used to provide a sound base for spatial analyses (Chapter 10) within Components 1, 2, 3, 4, and 5. This chapter is divided into three broad sections: (1) methods and examination of sources of error, (2) site chronology, and (3) occupation history for Components 2, 3, and 4 by activity area.

As Pettitt et al. (2003:1-3) note, no systematic quality control procedures has seen widespread use in archaeology (see also Waterbolk 1971; Hedges 2000; Aitken 1990). As radiocarbon dating represents the fundamental cornerstone of absolute dating of stratigraphy, components, and ultimately cultural constructs like traditions and complexes, evaluating individual radiocarbon assays is critical. Each assay represents an individual data point that must receive attention with respect to contamination, sample selection, and context. The radiocarbon analysis presented here attempts to assess radiocarbon assays with respect to each other in stratigraphic and activity area contexts, to potential causes of variation in age results, and to other classes of data. Only when all of these elements are addressed can radiocarbon data be integrated within the analytical framework used to interpret various facets of occupation activities within each component.

The objectives of (1) establishing a site chronology, with special emphasis on delineating relationships among components, and (2) assessing occupation history (activity areas within components) are problems at different temporal scales, entail different methods and analysis. As with most excavations, funding is limited, but given the problem orientation used in this research, I focused almost all available funding to provide radiocarbon dates on each cultural feature. This was necessary as contemporaneity of features within a structurally complex component cannot be assumed, but must be tested. Important aspects of site organization and function among faunal clusters, lithic clusters, and features required a highly resolved chronology. A side effect of this was the accumulation of numerous radiocarbon dates that could be used for stratigraphic analysis. Establishing site chronology necessitating dating wood charcoal fragments found within secure stratigraphic contexts. Most stratigraphic dates were already obtained by Holmes 1996 testing at the Lower Locus (Holmes 1998a:6). The major buried B horizons or paleosols were dated (R3, R4, and P1). This sequence was consistent with that established for the Upper Locus, after stratigraphic analysis (Potter 2002). The stratigraphic dates obtained through my excavation included another date on Paleosol 1 from a charcoal sample found just below a flake from Component 1, sixteen dates withinY4a and Y4b, and a date on a bone sample recovered within Unit IV gray sand. The results are described and analyzed below.

The second dating objective is assessing possible relationships among activity areas among Components 1, 2, 3, 4, and 5, especially within Component 3. This necessitated the strictest provenience control, on relatively large charcoal fragments (>5 mm) directly within the hearth matrices and mapped in plan view with 3-point provenience. In rare cases, charcoal from within the hearth matrix was selected due to the smaller sizes of the 3-pointed charcoal fragments. A sample large enough to enable the lowest laboratory error (or sigma) for this time range, ideally ±40 BP, was desired. This also necessitated using Accelerator Mass Spectrometry (AMS) dating, as the amount of charcoal necessary for conventional radiometric dates would require combining individual samples of different proveniences within each hearth. In addition, since all of the existing Lower Locus radiocarbon dates were AMS, the samples would allow more controlled comparisons (see discussion in Kunz et al. 2003 for potential differences in AMS and conventional dating of Late Pleistocene/Early Holocene samples).

The specific problem domains at Gerstle River include the precise temporal position of Components 2, 3, and 4 and feature contemporaneity within Component 3. The Component 4 hearth (Feature 7) was situated within massive aeolian silt with no discernible stratigraphy between it and the lower Component 3 materials. Feature 7 is structurally interesting, in that a series of large (compressed) burnt logs were found at the outer edges, a very different pattern than all of the Component 2 and Component 3 hearths, which are characterized by relatively small (<3 cm) fragments of charcoal and oxidized sediment. The relationships among the Component 3 hearth areas must be assessed through radiocarbon dating, as an independent check on contextual arguments of contemporaneity (see Chapter 9). Hearth dates with potentially co-occurrence (i.e., have statistically identical age estimates), or non-overlapping age estimates have very different implications regarding site structure and organization and interpretation of site use through time. Seasonality or prey species may play critical roles in understanding site use at Gerstle River. However, without an underlying basis for estimating age of occupation(s), it is difficult if not impossible to control for ambiguity regarding the number of discrete occupations, and therefore any hypothetical organizing principles inferred from the observed artifact, faunal, and feature patterns.

This analysis figures significantly in addressing a number of important issues relating to the Denali Complex (e.g., Mason et al. 2001, Hamilton and Goebel 1999, West 1996) and site structure in central Alaska (Potter 1999, 2000, 2004b), including addressing the function of various tool types such as microblades, burins, and various scraper forms, the presence (and/or absence) of bifacial tool forms, the co-occurrence of bison remains and microblades (see especially Holmes and Bacon 1982 and Stephenson et al. 2001), and subsistence-related questions (see Straus et al. 1996). This component offers a critical glimpse at a complex occupational history perhaps reflecting (a) a large camp with numerous co-occurring hearths, (b) multiple short visits over a course of seasons, or (c) multiple short visits over the course of years. Each scenario has critical implications regarding the lifeways of ancient Alaskans. These scenarios are partially exclusive, and radiocarbon dating provides the primary method for resolving this problem.

Prior to this research, no archaeological components were directly dated at the Gerstle River site, and only the uppermost component at the Upper Locus had associated stratigraphic dates (Rabich and Reger 1978). Previous researchers have obtained radiocarbon dates, primarily on Upper Locus materials, though no firepits or hearths were dated, and the dating must be considered to be indirect, as no direct associations between the archaeological materials and charcoal of cultural origin had been established. The general stratigraphic sequence was outlined by earlier researchers (Kimura et al. 1989; Holmes 1998a), however ambiguities and conflicting associations of dates and strata remained from this work (see Potter 2002).

Expectations Based on Stratigraphic and Contextual Factors

Various taphonomic and organizational factors affect site structure and the patterning of feature areas in relation to distribution, density, and association of artifacts and fauna. Control over stratigraphy, a clear understanding of taphonomic variables that could or did affect artifact and feature patterning is crucial to activity area analyses (see Brooks and Yellen 1987:63-64; Binford 1987, 1989). Chapter 4 details taphonomic factors that may effect radiocarbon dating at Gerstle River. Based on that analysis, the possibility of mixing of deposits is considered extremely remote.

The stratigraphic position of each component is secure (see Chapter 4). Component 2 hearths are stratigraphically separated from Component 3 hearths by about 20 cm of sterile loess and a discontinuous B horizon (R5). Component 2 hearths have discrete spatial distributions of artifacts spaced centrally around each hearth (though Feature 17 was truncated by the eroding bluff edge). Component 4 was separated from Component 3 by around 8-10 cm of sterile loess, and consists of lithic artifacts and faunal remains scattered near a hearth feature (Feature 7).

Component 3 contains ten hearths (Features 1, 3, 5, 9, 10, 12, 13, 14, 16, and 18), two charcoal scatters directly associated with artifact clusters (Features 8 and 11), and an apparent burned log (Feature 15, not dated). These features are stratigraphically associated and presently interpreted as including one or more occupations within a single technological tradition. Similar types of tools, material types, and faunal remains are present within a relatively narrow vertical distribution of ~5-10 cm associated with these hearths. The spatial separation of Areas A, B, C, and D suggests a single occupation with a number of activity areas or multiple spatially discrete occupations occurring at or nearly the same time. In other words, there is no stratigraphic separation of multiple occupations within Component 3, and the 3-point data presented in Chapter 4 show a unimodal distribution of about 5-10 vertical centimeters of cultural material across the site with very little turbation, highly suggestive of contemporaneous or nearly contemporaneous occupation(s) and material deposition. Feature contemporaneity within Component 3 is partially supported by the extremely thin vertical distribution of cultural materials, material type distributions, spatial distributions of artifacts and fauna, faunal weathering patterns, and tool and debitage class distributions. Fauna and artifacts related to Feature 7 were recovered in a discrete area (< 2 m^2) between 8-12 cm below R4, thus stratigraphically supporting a younger age for this feature.

All of these features are situated within a massive loess (aeolian silt) sediment (Y4) that is bracketed above by a Bwb horizon (R4) dating to 8380±50 BP (β-98433), and below by an undated discontinuous Bwb horizon (R5). A date of 9510±50 BP (β-134098) on Feature 2 in Component 2 yields a lower limiting date for the upper Y4 loess. These dates indicate that the Y4a loess was deposited over the course of almost 1300 calendar years. This range suggests that it is possible that Component 3 may be composed of a number of occupations of different ages. This question is important, as studies of intrasite organization are in a generally underdeveloped state in central Alaskan studies, and are generally ignored or oversimplified for this earlier prehistory (see discussion in Mason, et al. 2001; see also West 1996).

Deposition rates can be used to examine what portion of the site may have been visible to later occupants. Physically, largest cultural remains in Component 3 range from 3 cm high long bones to a 12 cm high cervid cranium. A deposition rate of 3.88 cm/100 years is obtained for the massive aeolian silt between Paleosol 1 and R4 (see Chapter 4). The deposition rates on Y4a include 2.04 cm/100 years between Components 3 and 4, and 5.73 cm/100 years between C4 and R4. Assuming the average rate of 3.88 cm/100 years, the faunal remains from Component 3 would have been totally covered in about 80-310 years.

Regarding feature structure, the cultural features in Components 2, 3, and 4 can be divided into two types, firepits and charcoal scatters. Firepits, with oxidized sediment, are generally 1-2 m in diameter with lenticular cross-sections. Charcoal scatters (Features 8 and 11) do not have oxidized or red-stained sediments associated with them. The fact that artifacts and fauna were found directly associated with these charcoal scatters (i.e., interspersed) suggests that these are cultural in origin.

Methods

This section is divided into discussions relating to scales of analysis, radiocarbon dating methods, evaluation of possible sources of variation in radiocarbon assays, sample selection and preparation, and analytical methods. All are important in evaluating appropriate methods to address the research questions outlined above.

Scales of Analysis

There are several problem areas in activity area analysis where radiocarbon control is critical. Contemporaneity of multiple features, re-use of an area, and re-occupation are all potential issues that can be addressed with radiocarbon dating samples with highly resolved provenience. The nature of the occupation(s) can be tested, i.e., contemporaneous (single year or sequential seasons), or non-contemporaneous (separated by decades or longer, etc). A component delineated by stratigraphy and a few radiocarbon dates should not be considered equivalent to an occupation.

Radiocarbon dating is a probabilistic technique (see Shott 1992). Therefore, the range of possibilities offered by numerous radiocarbon dates in the Early Holocene range may be too broad to demarcate occupations that may have lasted less than a day and were spaced from a single day to ~80 years (see below). The optimal procedure for this scale of analysis would be to have a minimum of four dates on each hearth in order to highly resolve various occupation scenario possibilities; however, given the number of hearths and the exorbitant costs, a more limited plan for dating each hearth or charcoal scatter was implemented. This plan yielded 16 radiocarbon dates (Feature 14 was dated twice when the first sample returned a date outside of the range of the other Component 3 dates, see below for discussion).

A number of labels are used in Alaskan archaeology when designating cultural manifestations within a stratified site. These include component, cultural zone, and cultural sub-zones (not labeled as such, but derived from the use of sub-headers within cultural zones). Often, the precise nature of the cultural manifestation is not clear, especially with regards to occupation span, occupation number, occupation history, and radiocarbon dating.

The spatio-temporal terms used in this study are here explicitly defined, in the hopes of allowing comparisons with other cultural manifestations at other sites. *Occupation* is here defined as a temporally localized residence at a location. Examples include the use of a location as a campsite for a single night, or manufacturing tools for a few hours. *Component* is here defined as one or more occupations that do not show evidence of extensive re-use. I have tried to specifically delimit these terms by observable stratigraphy and feature/artifact spatial organization. These are obviously arbitrary definitions and in some cases, they may not be suited to all the analytical problems posed by a site, but for the purposes of this study, they can be operationalized and examined with various datasets.

Various hierarchical scales of radiocarbon dating analysis can be distinguished from the individual sample to the region. The individual sample, two or more samples from an identical or similar context, two or more samples from within a stratigraphic sequence, and two or more samples from a local or wider regional setting. For the purposes of this analysis, radiocarbon data assemblages are distinguished for tests of contemporaneity and for evaluation scores defined by Pettitt et al. (2003). The largest data group contains all radiocarbon dates from the site (n=40). Another group contains all radiocarbon dates from *in situ* contexts (n=36). A smaller group contains all radiocarbon dates from the Lower Locus (n=25). Other groups include Component 2 dates (n=2), Component 3 dates (n=13), Component 4 dates (n=1), and secure stratigraphic dates from the Lower Locus (n=28). Each grouping contains different levels of uncertainty, and they are discussed and evaluated below.

Radiocarbon Dating Methods

There are at present two generally accepted methods of radiocarbon dating within archaeology, conventional radiometric dating (or beta decay, through gas proportional counting [GPC] or more commonly through liquid scintillation counting [LSC]) and accelerator mass spectrometry dating (AMS) (Taylor 1987; Hedges 2000). AMS is generally considered more accurate (and certainly more precise) method for radiocarbon dating, as it directly counts the ^{14}C atoms by means of accelerator mass spectrometers (AMS), rather than estimating the ^{14}C content by monitoring the decay rates.

Special requests were made to the laboratories within the shipment notes in 2001. These read as follows: "If any of the samples can be dated by the conventional radiometric method (non-AMS) with a precision of ± 70 years or less, then please inform me. If not, then they must all be run with the AMS method." Beta Analytic personnel informed me that all had to be run with the AMS method to achieve the requested precision.

The AMS method was selected because of several factors. First, the AMS method results in generally higher precision than conventional radiometric method. The highest precision was needed in order to differentiate among various occupation scenarios, including contemporaneous or separate occupations. Second, AMS permits stronger pretreatment for the removal of potential contaminants (Aitken 1990; Taylor 1987). Third, isotopic fractionation ($\delta^{13}C/^{12}C$) is directly calculated with the AMS method, not estimated, and corrections are applied, yielding a more accurate date. Fourth, smaller sample sizes are required for AMS versus radiometric[1], reducing the possibility for contamination when aggregating larger samples. Fifth, smaller sample sizes leave more material to be curated for further dating experiments.

[1] Typical charcoal samples sent to Beta Analytic yielded between ~50 mg and 200 mg clean charred material. Conventional dating with a one standard error of <70 years would have required 2-4 g of final carbon with extended counting given the expected age range (Ron Hatfield, Beta Analytic, 2003 personal communication).

Sample Selection and Preparation

Given the excellent organic preservation and well-defined stratigraphy, 173 charcoal/wood samples were taken from both stratigraphic (n=44) and cultural (n=129) contexts during the 1999-2003 investigation. A total of 4 separate 3-pointed charcoal samples directly associated with cultural features are available for Component 2, along with three hearth matrix bags for the two features (Features 2 and 17). A total of 92 separate 3-pointed charcoal samples directly associated with cultural features are available for Component 3, along with 53 hearth matrix bags for the 13 features (Features 1, 3, 5, 8-16, 18). An additional 25 charcoal samples were collected in direct association with Component 3 artifacts or Y4a stratum, level 2 outside of the hearth feature boundaries. These were generally small, isolated charcoal fragments. A total of 8 separate 3-pointed charcoal samples are directly associated with Hearth Feature 7 are available for Component 4, along with one hearth matrix bag.

Field treatment of radiocarbon samples was consistent throughout all years of excavation (1999-2003). Samples were isolated as much as possible by trowel and wooden probes from surrounding sediments. The samples were placed in an aluminum foil pouch with minimal handling and placed in 4 mil plastic archival bags. All radiocarbon samples were cleaned by the author prior to shipment to the radiocarbon laboratories. A stereoscope, hand lenses, dry brushes and tweezers were used to remove macroscopic contaminants, such as rootlets and sediments that remained on the samples. Samples of hearth charcoal were selected on the basis of size and location within the hearth. Charcoal fragments large enough to be plotted on feature plan-views were preferable (n=13), though some samples were taken from the hearth matrix when no suitable mapped charcoal fragments were available (n=3). Large single fragments of charcoal were preferred. The samples were then weighed (to 0.1 g) and packaged in aluminum foil and placed within clean plastic 4 mil archival bags.

Fifteen of the eighteen ^{14}C samples submitted for radiocarbon analysis during this investigation (1999-2004) had dry weights of between 100 and 2000 mg, averaging 421 mg, much higher than the 50 mg required by Beta Analytic for normal AMS dating. Selected charcoal fragments were single chunks between 2 and 7 mm in diameter. Five 2002 samples yielded between ~50 mg and 200 mg of clean charred material. All samples had a final carbon yield greater than 0.5 mg, most above 1 mg (Darden Hood 2003, Beta Analytic, personal communication). According to Laboratory correspondences, all samples submitted during this investigation provided enough carbon for accurate AMS analysis, and no problems were encountered during all analytical steps. Given the careful selection of charcoal fragments directly within each hearth, clear and direct associations between the hearths (events to be dated) and the samples (charcoal fragments) were obtained. Fragments were selected on the basis of size and position, small enough to be single pieces of charcoal and not agglomerations of numerous charcoal flecks, yet large enough to be from the hearth itself and not tiny possibly wind-blown flecks. As Hedges (2000:490) notes, large fragile charcoal fragments are not likely redeposited.

Of the 16 hearth charcoal samples submitted during this investigation, 13 (81.3%) were from 3-point provenienced specimens mapped prior to collection. The remaining 3 (18.7%), from Features 2, 3, and 10, were separated from hearth matrix bags or directly associated with the hearth features in screened contexts as no suitable 3-pointed piece was available.

Analytical Methods

This study requires that relatively high precision and accuracy be placed on the radiocarbon dating results. To this end, a sequence of tests and analyses were conducted on the radiocarbon results. These include (1) defining date assemblages (see above), (2) obtaining evaluation scores for each assemblage using conventional ages (Pettitt et al. 2003), (3) tests of contemporaneity and subsequent averaging for each date assemblage (Ward and Wilson 1978; see also Shott 1992), (4) calibration (Stuiver et al. 1998), (5) assessing the probability distributions of each sample, each assemblage, and averages after calibration, (6) assessing any remaining anomalous dates, and (7) developing scenarios of site occupation.

The date assemblages are described at the beginning of the chapter. While radiocarbon dates cannot be validated or verified without other dating techniques, they can be assessed for stratigraphic congruity and internal agreement (Hedges 2000). Various evaluation considerations have been described (Waterbolk 1971; Taylor 1987:105-146; Hedges 2000), but only Pettitt et al. (2003) have delineated a detailed scoring system. Following the evaluation criteria outlined in Pettitt et al. (2003), samples obtained and dated during the 1999-2004 Gerstle River investigation were assessed. Date assemblages on each component with one or more directly associated radiocarbon dates were assessed. The resulting evaluation scores can be assessed using their scale of rejection, provisional acceptance, or a more general acceptance. Pettitt et al. (2003) use *acceptance without question* for higher scores, but given the arbitrary nature of the algorithm, this evaluation method is merely used to provide a relatively objective method of assessing confidence in the radiocarbon date series.

Tests of contemporaneity and averaging of uncalibrated dates were performed using Calib v4.3 software (Stuiver and Reimer 1993; Ward and Wilson 1978; Long and Rippeteau 1974). Pooled averages of radiocarbon dates use the following equation:

$$A_p = (\sum A_i - S_i^2)/(\sum 1/S^2)$$

where A_p is the pooled mean of n radiocarbon dates, A_i is the uncalibrated radiocarbon date of the *i*th sample, and S_i^2 is the sum of several error terms (standard deviation of the assay, a product of its counting error, and the standard deviation of the calibration error). The calibration curve sigma is included in the weights.

The pair-wise tests of contemporaneity (Ward and Wilson 1978:23) used the equation:

$$T' = (\sum A_i - A_p)^2/S_i^2$$

where T' has a chi-square distribution with n-1 degrees of freedom.

Calibrations were calculated with Calib v4.3 software using atmospheric decadal averages of the Intcal98 terrestrial dataset (Stuiver and Reimer 1993; Stuiver et al. 1998), and radiocarbon distribution plots were made in Oxcal 3.9 software (Bronk Ramsey 2001).

The question of averaging radiocarbon dates is important and often unaddressed in some archaeological contexts (see Long and Ripeteau 1974; Ward and Wilson 1978). When is it appropriate, and under what circumstances should it not be used? What relationships among samples and features must be assumed or tested prior to averaging? Long and Rippeteau (1974:206) detail a continuum of conditions, which include (from most appropriate to least appropriate): split single samples (split samples), samples from within a single context (cross-check samples), from a single occupation surface, from the same stratigraphic unit, and from different sites based on stratigraphy or technology (similar artifact types). Averaging is considered appropriate for date assemblages within Component 2 and 3, as they are samples from identical stratigraphic contexts, with a preponderance of evidence suggesting "living floors."

While currently no statistical tests are in general use to assess contemporaneity of calibrated radiocarbon samples, one avenue for evaluating contemporaneity among calibrated dates is to examine the distributions (at 2σ) falling under the curve after calibration for each date assemblage (see below).

Results

Radiocarbon Dating Summary

All radiocarbon assays for Gerstle River (from both loci) are listed in Table 5.1. Following convention (Stuiver and Polach 1977; Stuiver and Kra 1986), radiocarbon results from this investigation include: conventional radiocarbon age (BP, or before physics) (corrected for ^{13}C fractionation, estimated for conventional radiometric dates and measured for AMS dates), calibrated age (cal BP) range of 2 standard deviations, material dated, and associations. Conventional radiocarbon ages and standard error are rounded to the nearest 10 years, therefore some of the assays are different than in Potter (2002) (e.g., WSU-4890, 3390±65 BP is listed as 3390±70 BP). Calibrations are based on the original conventional ages.

A series of forty radiocarbon assays have been obtained from Gerstle River, 16 at the Upper Locus (collected from 1977-1996) and 24 at the Lower Locus (collected from 1996-2003) (see Table 5.1). Seven laboratories have been used, 21 dates from Beta Analytic (β#), seven from Washington State University (WSU#), four from Nishina Memorial (N#), three from Arizona Accelerator Facility (AA#), two from Dicarb Radioisotope Company (DIC#), two from Oxford Radiocarbon Accelerator Unit (OxA#), and one from Geochron Laboratories (Gx#). All 26 dates from Beta, Arizona, and Oxford are AMS dates; the remaining 14, from Dicarb, Geochron, Nishina, and WSU are conventional radiometric dates.

Prior to this research, a total of 20 radiocarbon dates were available, primarily on upper strata at the Upper Locus. Rabich et al. 1978 report one date associated with their "Upper Component," here designated Component 7. Kimura et al. 1989 report six dates from the Upper Locus. Holmes (1998a) reports seven dates from the Upper Locus (with the addition of an unreported modern date associated with Test Pit 2 (WSU assay data sheet), four from the Lower Locus Bluff Test Pit, and one associated with a bluff face paleosol not correlated with the Lower Locus stratigraphy.

Table 5.1 Radiocarbon assays from Gerstle River (ordered by Locus and age).

Lab Number / method[2]	*Conventional Radiocarbon Age*[3]	*Calibrated Age*[4] *(2 σ)*	$\delta^{13}C/^{12}C$ [5]	*Material and Provenience*	*Ref.*
		Upper Locus Dates			
WSU-4889	Modern*	NA	NA	charred material, R3, Test Pit 2	3
WSU-4891	2110±150 BP*	2360-1710 cal BP	est.	charred material, Y2 top, Test Pit 5	4
WSU-4890	3390±70 BP?	3830-3470 cal BP	est.	charred material, R2 bottom or Y1, Test Pit 5	4
N-4959	3800±70 BP	4420-3930 cal BP	est.	charred material, Y1, A-Grid, Component 7	2
Gx-5950	4120±170 BP	5050-4150 cal BP	est.	charred material, Y1/R1 contact, A-Grid, upper limiting date of Component 6	1
N-4958	5050±90 BP	5990-5600 cal BP	est.	charred material, R2, A-Grid	2
N-5225	6040±110 BP*	7230-6640 cal BP	est.	charred material, Y4a, A-Grid	2
N-5226	6090±80 BP*	7230-6730 cal BP	est.	charred material, Y4a, A-Grid	2
WSU-4892	6220±80 BP	7310-6810 cal BP	est.	charred material, R3a, Test Pit 5	4
DIC-2849	6400±370/ 380 BP*	7970-6410 cal BP	est.	charred material, R3 or R4, A-Grid	2
WSU-4893	6470±310 BP*	7940-6670 cal BP	est.	charred material, Y4a, Test Pit 5	4
WSU-4888	7600±140 BP	8640-8060 cal BP	est.	charred material, R3b, Test Pit 1, upper limiting date of Component 5	4
DIC-2848	7660±310/ 330 BP*	9400-7790 cal BP	est.	charred material, Y4b, A-Grid	2
β-98433 AMS	8380±50 BP	9520-9160 cal BP	-26.9‰	charred material, R4, Test Pit 5, lower limiting date of Component 5	4
β-98436 AMS	10040±60 BP	12100-11260 cal BP	-25.4‰	charred material, P1, Test Pit 5	4
		Lower Locus Dates			
β-98435 AMS	6250±60 BP	7310-6990 cal BP	-27.4‰	charred material, R3a, Bluff Test Pit, lower limiting date of Component 6	4
WSU-4894	7330±200 BP	8540-7740 cal BP	est.	charred material, bluff face paleosol, not correlated	4
β-98434 AMS	8280±60 BP	9470-9030 cal BP	-26.0‰	charred material, R4, Bluff Test Pit	4
β-181680 AMS	8580±40 BP	9600-9490 cal BP	-25.0‰	hearth charcoal (Salix sp.), Y4a, Hearth Feature 14, Component 3	6
β-167396 AMS	8660±40 BP	9820-9540 cal BP	-24.8‰	hearth charcoal, Y4a, Hearth Feature 7, Component 4	6
β-191558 AMS	8760±40 BP	10110-9560 cal BP	-23.0‰	hearth charcoal, Y4a, Hearth Feature 14, Component 3	6
β- 183109 AMS	8820±50 BP	10150-9630 cal BP	-24.5‰	hearth charcoal, Y4a, Hearth Feature 16, Component 3	6
β-181678 AMS	8830±50 BP	10150-9690 cal BP	-24.9‰	hearth charcoal (Salix sp.), Y4a, Hearth Feature 12, Component 3	6
β-133750 AMS	8860±70 BP	10210-9630 cal BP	-25.6‰	hearth charcoal, Y4a, Hearth Feature 1, Component 3	6
β-167397 AMS	8890±40 BP	10190-9790 cal BP	-26.4‰	hearth charcoal, Y4a, Hearth Feature 5, Component 3	6
β-181679 AMS	8900±40 BP	10190-9790 cal BP	-25.2‰	hearth charcoal (Alnus sp.), Y4a, Hearth Feature 13, Component 3	6

[2] Methods include AMS where noted and conventional radiometric for all others.
[3] Discordant dates are noted with asterisks. All were from the Upper Locus (n=8) (see below and Potter 2002). Note that 3-point provenience cannot be established for N-4958, N-4959, N-5225, N-5226, DIC-2848, and DIC-2849 on the basis of existing records.
[4] Calibrated age ranges are calculated using Method A on the INTCAL 98 terrrestrial dendrochronological decadal dataset, rounded to the nearest ten years (Stuiver et al. 1998).
[5] All dates are corrected for isotopic fractionation.

Table 5.1 Continued.

β-167399 AMS	8910±40 BP	10190-9870 cal BP	-26.0‰	hearth charcoal, Y4a, Hearth Feature 10, Component 3	6
β-167395 AMS	8950±40 BP	10210-9920 cal BP	-25.1‰	hearth charcoal, Y4a, Hearth Feature 3, Component 3	6
AA-51254 AMS	9030±70 BP	10360-9920 cal BP	-24.6‰	hearth charcoal, Y4a, Hearth Feature 9, Component 3	6
β- 183108 AMS	9080±50 BP	10380-10180 cal BP	-24.0‰	hearth charcoal, Y4a, Hearth Feature 18, Component 3	6
β-167398 AMS	9130±40 BP	10400-10210 cal BP	-25.1‰	hearth charcoal, Y4a, charcoal scatter Feature 8, Component 3	6
AA-51253 AMS	9130±70 BP	10490-10190 cal BP	-23.6%	hearth charcoal, Y4a, charcoal scatter Feature 11, Component 3	6
β-183110 AMS	9400±50 BP	11040-10430 cal BP	-23.8‰	hearth charcoal, Y4b, Hearth Feature 17, Component 2	6
OxA-11246 AMS	9400±60 BP	11040-10430 cal BP	-20.6‰	*Bison priscus*, R. metatarsal, Lower Locus, disturbed	5
OxA-11962 AMS	9510±40 BP	11090-10600 cal BP	-20.0‰	*Bison priscus*, R. metatarsal, Lower Locus, disturbed	5
β-134098 AMS	9510±50 BP	11090-10580 cal BP	-26.4‰	hearth charcoal, Y4b, Hearth Feature 2, Component 2	6
β-133751 AMS	9740±50 BP	11230-10890 cal BP	-25.9‰	charred material, P1, N48E40 paleosol directly underlying Component 1	6
β-98432 AMS	9970±60 BP	11910-11220 cal BP	-28.9‰	charred material, P1, Bluff Test Pit	4
AA-51252[6] AMS	11980±120 BP	15320-13620 cal BP	-20.5‰	mammal bone collagen, Unit IV, N48E44	6
β-109267 AMS	15150±70 BP	18710-17580 cal BP	-20.9‰	*Equus* sp. radius, Lower Locus, disturbed context	4

References:
1. Rabich et al. 1978 (n=1), 2. Kimura et al. 1989 (n=6), 3. WSU data sheet 1996 (n=1), 4. Holmes 1998a (n=12), 5. Beth Shapiro, personal communication, 7/22/2003 and Tom Hingham, Oxford Accelerator Laboratory, 9/9/2003 (n=2), 6. This dissertation (n=18)

During this research, a series of 18 AMS radiocarbon dates were run on hearth charcoal or bone fragments from the Lower Locus with stratigraphic and spatial provenience controls. In addition, two *Bison priscus* metatarsals found in disturbed contexts at the Lower Locus during previous collections were dated as pat of mtDNA analysis by Alan Cooper and Beth Shapiro (Shapiro et al. 2004). Three dates were presented previously (Potter 2001), along with analysis of provenience and problems with previously published dates at the site (Potter 2002).

The results of the dating project add a significant amount of controlled data on the problems discussed above. All of the Lower Locus *in situ* dates are in the predicted range, and no contamination is apparent in their distribution. All dates are stratigraphically consistent with each other and with previous dates (Holmes 1998a). All 21 radiocarbon dates for the Lower Locus are

[6] This sample had a 20.77% collagen yield. The collagen was combusted as graphite, yielding the ^{14}C date. This collagen fraction was one of the largest that the laboratory manager had seen (Mitzi Dimartino, NSF Arizona AMS facility, personal communication, 1/24/2003).

internally and stratigraphically consistent except for β-181680 (see below). Each radiocarbon assay is discussed below.

Evaluation of Possible Sources of Variation in Radiocarbon Assays

There are several known sources of variation in radiocarbon dating (Taylor 1987; Aitken 1990; Waterbolk 1971; Pettitt et al. 2003). This variation can be divided into natural sources of variation, such as systemic effects, contamination, distribution of ^{14}C in nature, etc., and contextual sources of variation, such as association between material dated and event to be dated, nature and duration of occupation, etc. Each potential source of error of the Gerstle River radiocarbon dates is assessed here.

Natural Sources of Variation

Systemic Effects and Contamination

Recent atmospheric ^{14}C concentration variation, such as the Suess effect (fossil fuel burning affecting material from about 300 to 0 BP) and the atomic bomb effect, are not likely to affect the samples, which are non-modern, buried within silt loess, and retrieved from *in situ* deposits.

De Vries effects, potentially related to cosmic ray fluxes resulting from heliomagnetic processes (e.g., sunspots or solar flare activity), are not currently corrected for and are ignored here (see Taylor 1987:30-33).

Uncertainty relating to the radiocarbon isotope half-life, 5568±30 BP for the Libby half-life and 5730±40 BP for the Cambridge half-life, is not included with the standard error measures of the reported dates by convention (Stuiver and Polach 1977), and is not considered further.

Isotopic fractionation is enrichment or depletion of the stable isotope ratios $\delta^{13}C/^{12}C$. This value is generally normalized at –25.0‰ on conventional radiometric dates by Beta Analytic and Geochron. It is unknown if Dicarb, Nishina Memorial, or WSU use or used this estimation. The AMS method, (Beta Analytic, Arizona Accelerator Facility, and Oxford Radiocarbon Accelerator Unit) directly measures the ratio, allowing for the application of a correction (generally 10-40 years). Thus, all samples dated during this project (1999-2004) are corrected for this fractionation and are reported here as conventional radiocarbon ages (Stuiver and Polach 1977).

The concentration of ^{14}C throughout the biosphere is not constant, and marine reservoir effects are especially pernicious in archaeological radiocarbon analyses (see Taylor 1987:33-34). However, no marine reservoir corrections are necessary at Gerstle River, as all samples were terrestrial in origin, charred wood, charcoal, or ungulate faunal remains.

Contaminants that might yield erroneously old dates such as lignite were not observed in the immediate site area. Modern humic acids and rootlets incorporated into the samples might lead to erroneously young dates. However, the chemical pre-treatment by radiocarbon laboratories, acid/alkali/acid washes[7], are designed to eliminate potential carbonate, humic acid, and rootlet contaminants. Furthermore, all rootlets were removed from the sample with the aid of 10x lens prior to submittal. No contaminants were reported during the laboratory analyses. No known forms of coal have been noted in the area, though calcium carbonate is found in the lower Y4 silt. While $CaCO_2$ is present in the loess and sands layers (see Dilley 1998:278), no pedogenic carbonate features were noted in association with any of the *in situ* submitted samples. None of the samples were water-saturated during excavation. All samples were recovered from undisturbed stratigraphic contexts with clear stratigraphic and horizontal controls. No evidence of extensive groundwater leaching was found at the site, and the stratigraphy and sediment characteristics are consistent with a well-drained wind-blown silt depositional environment.

In the subarctic, tree roots and root remnants may extend downward in the sediment column. Forest fires may thus introduce charcoal through these roots into older layers, or modern rootlets may be incorporated in the samples. For this reason, and the supply of larger charcoal fragments in well-stratified contexts, no soil organics (bulk samples) were selected for radiocarbon dating, as they are more susceptible to contamination and contextual ambiguity (Taylor 1987:62). Root penetration was observed to be limited at the site, and the excavation process was carefully controlled (see Chapter 4). Charcoal for each sample was carefully selected on the basis of provenience within the hearth features and association with artifacts and faunal remains. Rootlets were removed during sample pretreatment. Possible contamination by more recent burns is considered negligible.

Volcanic emanations of ^{14}C depleted CO_2 can cause radiocarbon ages to be anomalously old (Taylor 1987:131-132). However, there are no known tephras (volcanic ashes) for the time period of occupation. The only tephra layer present at the site is situated just below the modern organic horizon, well above the components at the Lower Locus.

Calibration for Changes in Atmospheric ^{14}C Concentrations

The atmospheric concentration of ^{14}C has not been constant, and conventional radiocarbon ages must be calibrated against independent data sets, such as dendrochronologies and coral chronologies, in order to correct for these past variations (see Stuiver et al. 1998; Taylor 1987:133-136; Edwards et al. 1993; Björck et al. 1996; Kitigawa and van der Plicht 1998). Therefore, the dates are analyzed in both uncalibrated and calibrated forms (see below). Late Pleistocene and Early Holocene radiocarbon dates can potentially be skewed by (1) steep slopes of BP/cal BP that can overestimates dispersion of a series of dates on the same event (such as around 8600 BP) and (2) flat slopes (plateaus) that overestimates homogeneity of a series of dates from different events. A well-known plateau, or period of lowered $^{14}C/^{12}C$ ratios, has been described between 11000 and 12300 calibrated years BP (corresponding to ~10000-10500 radiocarbon years BP), correlating to the Younger Dryas (Edwards et al. 1993; Björck et al. 1996). This does not affect the period of site occupation for any of the components at Gerstle River. The slope between radiocarbon age and dendrochronological age for the period of Component 3 occupation(s), i.e., between 10000 and 8000 radiocarbon years BP show no large horizontal or steep slopes. Finally, the calibration program used in this study (see below) also incorporates the more accurate Cambridge half-life of 5730±40 BP, rather than the standard Libby half-life of 5568±30 BP, used in reporting conventional radiocarbon ages.

Issues Relating to Bone Samples

There are specific radiocarbon dating issues relating to bone samples, of which there are four at Gerstle River Lower Locus. While bones often yield a better association between the

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[7] Summarized, this consists of HCl acid washes to eliminate carbonates, NaOH alkali wash to remove secondary organic acids, a final acid rinse to neutralize the solution. During these rinses, remaining mechanical contaminants, such as rootlets, would be eliminated (from Beta Analytic's website,

event age and the radiocarbon age, charcoal can often give more reliable dates for a number of reasons. Bone is composed of an inorganic fraction, apatite, and an organic fraction, protein collagen. Bone apatite is more susceptible to contamination by carbonates than collagen, and is generally treated with caution (Hassan et al. 1977; Hedges and van Klinken 1992). Modern laboratories generally extract collagen or specific amino acids for dating (Stafford et al. 1987; see also Taylor 1987:53-61).

Two of the Gerstle River bone samples are on *Bison priscus* bones from disturbed contexts, run by Oxford Accelerator Unit. A third sample was on an unidentified large mammal bone fragment (0.2 g) from Unit IV sand, run by Arizona Accelerator Facility. The fourth sample was an *Equus* sp. bone from disturbed contexts, run by Beta Analytic (Holmes 1998a). In all four cases, the final carbon sample was derived from the collagen. It is pertinent to note that none of the activity area related questions utilize any of the bone dates.

Inter-Laboratory Variation and Laboratory Error

The most recent international inter-laboratory comparison study (FIRI) shows that 122 of 1056 assays (11.6%) were anomalous, about twice as high as expected by change (α=0.05) (Boaretto, et al. 2003:149). Most of these anomalies (87%) came from laboratories using liquid scintillation counting (LSC) (2003:149). They do not further elaborate causes of errors, but they recommend that laboratory use of standards of known ages is important for cross-checking. Inter-laboratory variation is ignored for the purposes of this study, as 20 of the 26 dates from the Lower Locus (77%) were produced by one facility, Beta Analytic. Three dates were obtained from Arizona Accelerator Facility, two dates on disturbed bone materials were obtained from Oxford Accelerator Unit, and one uncorrelated paleosol date (Holmes 1998a) was obtained through Washington State University. Thus, 19 of the 22 *in situ* dates at the Lower Locus (86%) were produced by Beta Analytic.

For the purposes of this study, inter-laboratory variation is not further considered, with the exception of Dicarb Radioisotope Laboratory (Dicarb). Reuther (2003) examined the hypothesis that Dicarb results were erroneous (see Gerlach and Mason 1992) using a series of cross-check samples from the Croxton site. The Dicarb samples were between 410 and 3330

http://www.radiocarbon.com/pretreatment.htm, visited 7/1/2004) years younger than cross-check Beta and Geochron uncalibrated assays (Reuther 2003:62). Reuther's assessment is that the Dicarb dates are consistently too young and are unsystematically in error (Reuther 2003, personal communication). The Mesa site and Gerstle River both have Dicarb assays run in the 1980s (Kunz et al. 2003; Kimura et al. 1989). The Mesa sample, DIC-1589, yielded a date of 7620±95 BP on a series of samples from multiple areas in Locality B. A portion of that sample was later dated to 10,060±70 (β -52606), suggesting the Dicarb date is 2440 years too young. The bulk of the later radiocarbon assays (41 of 44 AMS dates) document Mesa site occupation(s) between 9700 and 10300 BP (Kunz et al. 2003:19-21).

The two Dicarb assays run on Gerstle River samples have ambiguities in documentation and provenience (see Potter 2002). DIC-2848 (7660±310/330 BP) is associated with stratum Y4b in Kotani (n.d.) and Kimura et al. (1989:211). DIC-2849 (6400±370/380) is associated with stratum R3 in Kotani (n.d.), but with R4 in Kimura et al. (1989). No specific provenience information can be found for either of these samples on the available literature of the 1983-1985 excavations (consisting of Kimura et al. (1989), a single stratigraphic profile by Kotani (n.d.), original stratigraphic profiles and plan views, and the site catalogs for both years). Stratigraphic and radiocarbon correlations presented in Potter (2002) and here (see below) indicate that stratum R3a actually dates to 6240±50 BP (average of two assays), stratum R4 actually dates to 8340±40 BP (average of two assays), and stratum Y4b actually dates to 9450±40 BP (weighted average of two assays). Thus, DIC-2848 is about 1790 years too young, and DIC-2849 is 1940 years too young or 160 years too old depending upon the actual stratigraphic association. Given the consistent relatively younger ages of Dicarb assays relative to other laboratories, it is suggested here that DIC-2849 probably relates to stratum R4.

Contextual Sources of Variation

The two major contextual sources of variation in radiocarbon dating are (1) the association between the sample to be dated and the event(s) the sample is meant to date and (2) differences in age between the date of the target event (i.e., burning within a hearth), and date of the radiocarbon event (i.e., death of the tree) (see Taylor 1987; Waterbolk 1971; Schiffer 1987). The latter is often termed "old wood" effect. Factors that can result in problematic associations between the sample and the event include mixing of deposits through natural or anthropogenic disturbance and size and nature of the sample. Because AMS can be used to date very tiny samples (minimum of 5 milligrams), the problem of incorporation of such small particles within a seemingly secure matrix is heightened. On the opposite end, samples must be large (minimum of 1.7 grams, 30 grams recommended), and often samples from disparate proveniences must be combined in order to reach the minimum requirements. Sample sizes are discussed below, but are generally large enough that they were not likely blown into the hearths by wind, and they are fragile enough that redeposition is considered unlikely. In no case were samples from separate proveniences combined.

Samples can be displaced from their original position by a variety of natural and/or anthropogenic processes (see Schiffer 1987; Taylor 1987). Radiocarbon dates on samples within paleosols are often hetereogeneous, and can be more indirectly related to the event (paleosol formation) than hearth charcoal within more secure contexts (Hedges 2000:477). Taphonomic issues are discussed in Chapter 4. The horizontal stratigraphy, lack of vertical movement of artifacts and fauna through the sediment column, spatial patterning of the features and fauna (see 3d plots in Chapter 4), and the general lack of turbation by cryogenic or biogenic agents all are consistent with limited vertical transport of charcoal fragments within sediments between stratum R2 to the colluvial layer at Unit IV at the Lower Locus. No taphonomic disturbance features such as krotovinas or solifluction lobes were observed in the cultural strata. Contamination of charcoal as a result of taphonomic factor is therefore considered unlikely.

The control offered by precise sampling of single charcoal fragments from within firepit features mitigates any contextual uncertainties. The association of the dated samples and the events they are intended to date at the Lower Locus cultural features is quite high. Potential differences of radiocarbon ages at plant death and use within cultural contexts as a hearth fuel is discussed here. Taxonomic identification analysis was undertaken for three samples from Component 3 hearths, Features 12, 13, and 14 (see Chapter 9). Two fragments of *Salix* sp. were identified within the sample submitted for Feature 14 (β-181680). The sample submitted for Feature 13 (β-181679) is a twig of *Alnus* sp., weighing 0.1 g. Two twig fragments of *Salix* sp. were identified in the sample submitted for Feature 12 (β-181678). Neither *Alnus* sp. nor *Salix* sp. are particularly long-lived genera, and are generally small, from shrub to small tree in size (Viereck and Little 1972).

As ^{14}C dates on driftwood may be up to several hundred years older than the hearth burn event, it is important to control for this possibility. Small charcoal fragments were selected for dating, as these were likely gathered locally and were not likely to be preserved for extended lengths of time as driftwood. Twig remains found within these hearths are small, generally ~5 mm in diameter, and the size of the hearths are generally less than 1 m in diameter, both suggesting that these fires were not fueled by driftwood or very large tree branches (with the possible exception of Hearth Feature 7).

Plants containing "many annual growth rings will return a weighted average of the date for when the cellulose of the wood was formed" (Hedges 2000:469), which may be considerably different if long-lived trees are used for firewood. Short-growth material, such as seeds, would enable more precise relationship between radiocarbon event and archaeological event; however, few seeds are found in this context, and the association of the seeds and the archaeological features may be tenuous.

Other contextual issues center around the nature of the activity dated, that is, the construction and burning of wood fuel within hearth features. These events are likely very short term, on the order of a few hours or tens of hours at most. The charcoal fragments selected for dating are between the sizes where wind-blown redeposition is unlikely. In any event, the deposition rate (discussed below) suggests that the features were relatively quickly capped by aeolian silt after initial deposition. There is no evidence of colluvium within strata Y4a and Y4b. Charcoal fragments are not scattered within these layers, and are confined to hearth areas, with the exception of charcoal scatter features 8 and 11. Re-use of hearth features is always a potential problem, but given the depth of time, with the standard error at ±100-200 radiocarbon years at 2 σ, and the lack of extensive smearing feature edges or dispersal of articulated bones and flake scatters, feature re-use at significantly later dates is tentatively rejected.

Site Chronology

A provisional site chronology was developed and described in Potter (2002). This section summarizes that work and assesses the site chronology with the addition of new radiocarbon dates acquired since 2001. All of the dates obtained through this research and many of the earlier dates can be used for developing the site chronology. Of the total 40 radiocarbon samples from both loci, 36 (90%) are from *in situ* deposits where the provenience was described in some way. Four assays are rejected for establishing a site chronology based on the lack of meaningful provenience information (WSU-4894, OxA-11246, OxA-11962, and β-109267). Three are bone fragments from disturbed contexts, and one is from an "paleosol, not correlated" at the Lower Locus (Holmes 1998a:16). In addition to these four dates, the six dates described by Kimura et al. (1989) and Kotani (n.d.) have conflicting or ambiguous provenience with respect to stratigraphy (N-4958, N-4959, N-5225, N-5226, DIC-2848, and DIC-2849, see Potter (2002) for specific details). However, all of these are assessed with respect to their possible stratigraphic positions, following Potter (2002). These dates have not been correlated with exact 3-point provenience (or even any horizontal provenience) in any available document. Furthermore, the two Dicarb dates are questionable due to problems with that laboratory (Reuther 2003). This leaves 30 *in situ* dates from both loci, 9 at the Upper Locus and 21 at the Lower Locus. These dates are assessed below by associated strata, from lowermost to uppermost. Table 5:2 lists the comparisons among strata with multiple radiocarbon dates, including contemporaneity tests and pooled averages. Table 5.3 lists the concordant sequence of radiocarbon dates relevant for site chronology as defined below. Figure 5.1 illustrates the calibrated results of all dates from *in situ* contexts except WSU-4889, which yielded a modern date.

The lowest sediments at Gerstle River remain undated. No charcoal, wood, or bone samples were present associated with Units II, and III. The presence of *Equus* sp. bones and teeth and the possible *Saiga tataricus* humerus in disturbed contexts at the Lower Locus may be used to infer the potential antiquity of these sediments. An *Equus* sp. radius provided an AMS date of 15150±70 BP[8] (β-109267), calibrated to between 18710-17580 cal BP. The saiga specimen has not been dated, but the available dates (n=17) on Alaskan, Siberian, and Canadian specimens suggests two clusters, one between 25750±450 BP (AA-3892) and 37000±910 (GSC-3050) and the other between 12220±130 BP (AA-3077) and 15360±130 BP (AA-3892) (Guthrie et al. 2001). The Gerstle River saiga specimen may date to this later cluster. The lack of fragmentation on the *Equus* sp. remains suggests that they may not have been associated with the colluvial layer (Unit IV) but perhaps with the underlying sand (Unit III).

Unit IV is interpreted as a colluvial stratum, originating further upslope to the north, and is therefore considered disturbed. A small unidentifiable mammal bone fragment weighing 0.2 g was screened from within this statum in 2001 (UA2001-62-1579). Another small bone fragment was recovered from Unit IV in 2003 (UA2003-54-1507). No charcoal or other bones were found in this statum. Collagen from the first bone was dated to 11980±120 BP (AA-51252). There are a

[8] The measured ^{14}C age was previously reported in Holmes (1998a) as 15090±70 BP, the conventional ^{14}C age (after correction for the $\delta^{13}C$ ratio) is 15150±70 BP.

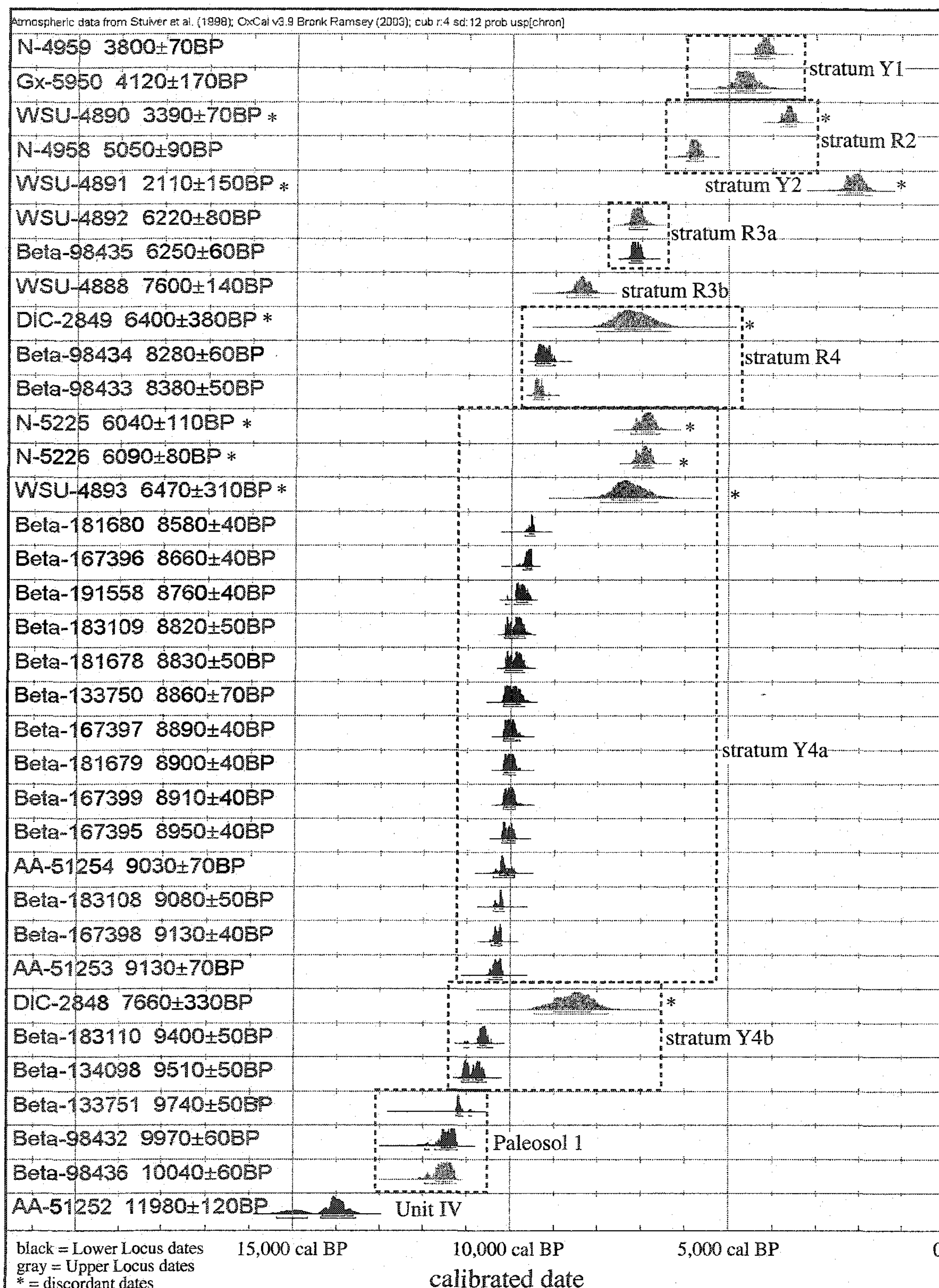

Figure 5.1 Calibrated results for all ^{14}C dates from *in situ* deposits, ordered by depth (stratum) and age within stratum.

Table 5.2 Radiocarbon comparisons among strata with multiple dates.

Group	*Assays*	*$A_p \pm V(A_p)$*	*T' (χ^2 critical value)*	*Contemporaneous*
Y1, all	3800, 4120 BP	3842±62 BP	3.06 (3.84)	Yes
R3a+R3b	6220, 6250, 7600 BP	6397±48 BP	82.44 (5.99)	No
R3a	6220, 6250 BP	6239±51 BP	0.08 (3.84)	Yes
R4, all	8280, 8380 BP	8337±43 BP	1.34 (3.84)	Yes
Y4a, all	See Table 5.5 below			
Y4b, all	See Table 5.5 below			
P1, all	9740, 9970, 10040 BP	9893±35 BP	14.68 (5.99)	No
P1, all Lower Locus	9740, 9970 BP	9832±42 BP	7.37 (3.84)	No
P1, all but 9740 BP	9970, 10040 BP	10005±46 BP	0.58 (3.84)	Yes

Table 5.3 Gerstle River site chronology (concordant suite of stratigraphic dates).

Stratum	*Assays*	*$A_p \pm V(A_p)$, single date, or estimated radiocarbon age*	*Calibrated age (2σ)*
Overburden (Lower Locus)	Undated	Undated	<20 years ago
O horizon	Undated	Between 3842 BP and modern	N/A
A horizon			
Tephra			
Y1 (Component 7)	3800, 4120 BP	3842±62 BP	4420-4020 cal BP
R2	5050 BP	5050±90 BP	5990-5600 cal BP
Y2 (Component 6)	Undated	Between 5050 and 6239 BP	N/A
R3a	6220, 6250 BP	6239±51 BP	7270-7000 cal BP
R3b	7600 BP	7600±140 BP	8640-8060 cal BP
Y3 (Component 5)	Undated	Between 7600 and 8337 BP	N/A
R4	8280, 8380 BP	8337±43 BP	9480-9150 cal BP
Y4a (Components 3 and 4)	8660, 8760, 8820, 8830, 8860, 8890, 8900, 8910, 8950, 9030, 9080, 9130, 9130 BP	8660±40 – 9130±70 BP	9820-9540 cal BP to 10490-10190 cal BP
R5	Undated	Between 9130 and 9400 BP	N/A
Y4b (Component 2)	9400, 9510 BP	9449±41 BP	11060-10560 cal BP
Sand 2	Undated	Between 9510 and 9740 BP	N/A
Y5a (Component 1)			
P1	9740, 9970, 10040 BP	9893±35 BP	11340-11200 cal BP
Y5b	Undated	Between 10040 and 11980 BP	N/A
Unit VIb Yellow sand			
Unit VIa Dark brown sand			
Unit V Gray sand (without ventifacts)			
Unit IV Gray sand with ventifacts	11980 BP	11980±120 BP	15320-13620 cal BP
Unit III Gray sand (grus)	Undated (15150 BP?)	Older than 11980 BP	Undated (18710-17580 cal BP?)
Unit II Degrading bedrock			
Unit I Weathered granitic bedrock			

variety of scenarios accounting for the deposition of this bone within Unit IV. It may have been redeposited from upslope during the colluvial event(s). It may have been deposited after Unit IV deposition and before Unit V sand accumulation. It may have been deposited within the Unit V sand and mixed with Unit IV sediments. It may also have been mixed into Unit IV stratum from below (Unit III). However, the boundaries of Unit IV are relatively clear with little gradation with the sediments above or below. Both bone specimens are clearly associated with ventifacts from Unit IV. Therefore, the second and last hypotheses do not appear to be supported. The first and third cannot be refuted based on the present evidence. Therefore, this date may be associated with this stratum as a *terminus ante quem*, that is, a lower limiting date for Unit V.

No dates are associated with strata between Unit IV and Unit VIb, but they likely date to between 11980±120 BP and 9893±35 BP (see below).

Unit VII (lower loess) consists of three sub-units, Y5a mottled loess, Paleosol 1, and Y5b mottled loess. Of these, only Paleosol 1 has associated charcoal fragments. Three dates have been obtained on charcoal samples from Paleosol 1, one at the Upper Locus (β-98436), and two at the Lower Locus (β-98432, β-133751). Two of these dates are contemporaneous (T'=0.58), yielding a pooled average of 10005±46 BP, but β-133751 appears a little young compared with the other Lower Locus date, β-98432 (T'=7.37, compared with χ^2=3.84). However, these dates are very near the Younger Dryas radiocarbon plateau (Edwards et al. 1993), so the test may be too conservative. A pooled average of all three dates is 9893±35 BP is used here for Paleosol 1 formation.

No dates are associated with Unit VII sand layers, though they likely date to between 9893±35 BP and 9449±41 BP (see below).

Unit IX consists of the remaining Holocene paleosols and sediments at Gerstle River, and each will be discussed separately.

Stratum Y4b is a massive aeolian silt with very little naturally occurring charcoal. Two oxidized hearths associated with Component 2 have been dated. Both are statistically the same age (T'=1.77), and the pooled average is 9449±41 BP. An Upper Locus date of 7660+310/-330 (DIC-2848) is also associated with Y4b, but is excluded due to laboratory unreliability (Reuther 2003) and provenience ambiguities.

Stratum R5 is a discontinuous Bw horizon, and while not dated, it likely dates to between pooled averages of strata Y4b and Y4a, 9449±41 BP and 8882±17 BP (see below). Another approach is to average the youngest Y4b date and the oldest Y4a date, given the clear stratigraphic separation, lack of extreme dates, and lack of reversals between these strata. These dates, 9400±50 BP and 9130±40 BP yield an average of 9238±35 for R5.

Stratum Y4a is a massive aeolian silt with little naturally occurring charcoal, averaging 20-30 cm thick. Samples from eleven oxidized hearths and two charcoal scatters associated with Components 3 and 4 have been dated at the Lower Locus. These dates range from 8580±40 BP to 9130±40 BP. A date of 6470±310 BP (WSU-4893) on Y4a at the Upper Locus can be excluded due to the high standard error and the discordance with the preponderance of dates (n=14). A detailed analysis of these dates with respect to activity area and feature related questions is provided below. For the purpose of stratigraphic dates, only one reversal is noted within Y4a, a Component 3 hearth dated to 8580±40 BP lies below the Component 4 hearth dated to 8660±40 BP. However, the preponderance of the radiocarbon evidence suggests that the former date should be discarded, as a later date (8760±40 BP) run on the same feature is more in accordance with the remaining 12 dates from this strata. Thus, stratum Y4a at the Lower Locus is dated by a series of 13 concordant dates ranging from 8660±40 BP to 9130±40 BP.

Two assays are associated with strata Y4a at the Upper Locus, N-5225 (6040±110 BP) and N-5226 (6090±80 BP). Neither of these dates appear in Kotani (n.d.). Kimura et al. only list N-5225 on their stratigraphic profile and radiocarbon date table (1989:210, 213). Since neither of these dates is tied to a three-pointed sample with unambiguous stratigraphic provenience, they are excluded here.

Stratum R4 is a continuous Bw horizon with three associated radiocarbon dates, two from the Upper Locus and one from the Lower Locus. One of the dates, DIC-2849 (6400+370/-380) is excluded because (1) the provenience on this date is ambiguous, as Kimura et al. (1989) associate it with stratum R4, but Kotani (n.d.) associates it with R3, and (2) Dicarb dates are considered unreliable (Reuther 2003). The remaining two dates[9], one from each locus, are statistically the same age (T'=1.34), yielding a pooled average of 8337±43 BP.

Stratum Y3 is a massive aeolian silt with a number of thin charcoal-rich paleosols. This stratum is undated, and no clearly derived charcoal fragments were obtained in association with Component 5. An estimate of the age of this stratum can be derived from the R4 average and R3b date (i.e., between 8337±43 BP and 7600±140 BP, WSU-4888). These bracketing dates yield a pooled average of 8259±46 BP. The large standard error of the WSU-4888 date skews

[9] Note that the provenience information for these two dates, β-98434 (8280±60 BP) and β-98433 (8380±50 BP) are reversed in Potter (2002:88).

this average to the R4 average, and an unweighted average of 7969 BP may more accurately reflect the age of this stratum, and the associated Component 5.

Stratum R3 consists of two discontinuous Bw horizons, labeled R3a (upper) and R3b (lower). Two radiocarbon dates are associated with R3a, two at the Upper Locus (WSU-4892) and one at the Lower Locus (β-98435). A single date is associated with R3b, at the Upper Locus (WSU-4888, 7600±140 BP). The two dates for R3a are statistically the same age (T'=0.08), and yield a pooled average of 6239±51 BP. A fourth date associated with R3 (not further distinguished to R3a or R3b) at the Upper Locus is excluded as anomalous, as it returned a modern date (WSU-4889). Therefore, R3a is considered to date to 6239±51 BP, and R3b to 7600±140 BP.

For strata above R3, only a series of dates from the Upper Locus is present, as the Lower Locus disturbed overburden generally extends to R3.

Stratum Y2 is an aeolian silt. Only one assay, WSU-4891 within Test Pit 5, was obtained from this unit. This date, 2110±150 BP, is considered anomalous by Holmes (2000, personal communication). The date is clearly too young when considering the dates on strata R2 and Y1 (n=4).

Stratum R2 is a continuous Bw horizon, and is associated with two radiocarbon assays, N-4958 (5050±90 BP) and WSU-4890 (3390±70 BP). The former is considered to effectively date this stratum given the preponderance of dates for Y1, and because the WSU-4890 date could be associated with R1, Y1, or R2, given the lack of an intervening Y1 at that provenience (see below, under stratum Y1).

Stratum Y1 has two, possibly three associated radiocarbon assays, N-4959, Gx-5950, and possibly WSU-4890 (Kimura et al. 1989; Rabich and Reger 1978; Holmes 1998a). The uppermost cultural component, Component 7, is associated with this strata, and of all of the dates in Kimura et al. (1989), N-4959 is likely the most acceptable given this clear association in the text and the agreement with Kotani's (n.d.) stratigraphic profile. Gx-5950 is associated with the contact between Y1 and the underlying R2 (described as soil units 2/3 in Rabich and Reger 1978:I-3). These two dates are contemporaneous (T'=3.06), and provide a pooled average (A_p) of 3842±62 BP for stratum Y1 and Component 7. The WSU-4890 date (3390±70 BP) was collected from R2 in Test Pit 5. The WSU-4890 sample taken from R1b was situated at a place where the Y1 layer was not represented. This date may be associated with Y1 instead of R2 because in Test Pit 5, R1 and R2 coalesced with only discrete lenses of Y1. Approximately 20 cm to the west, Y1 appears at about 6 cm above where the sample was taken. This sample could potentially be from Y1 if that stratum were better expressed in the northeastern part of unit N516E493.

There are currently no radiocarbon assays associated with the uppermost strata (Surface to Y1) at Gerstle River, at either Locus. The tephra present below the modern O horizon remains undated, but is younger than 3842±62 BP (see above).

Dates out of context

In addition to the *in situ* dates, four samples without clear contexts have also been dated at the Lower Locus (WSU-4894, OxA-11246, OxA-11962, and β-109267). The WSU-4894 assay (7330±200 BP) was taken from the eroding bluff face of the Lower Locus in 1996, but was not correlated with the stratigraphy (Holmes 1998a). The *Equus* sp. date (β-109267) was discussed previously. The remaining two dates were part of a DNA study of bison evolution (Shapiro et al. 2004). Shapiro et al. (2004) dated two separate *Bison priscus* R metatarsals from the bluff surface (UA97-61-229 and UA97-61-231, both collected in 1996 by Holmes). These samples returned dates of 9400±60 BP and 9510±40 BP respectively. While these dates are within the range of Component 2 hearth dates, their association with any cultural component at Gerstle River is unwarranted.

Occupation History

Chronological resolution at Gerstle River is very fine, almost unprecedented for a site of this age in Alaska. Figure 5.2 shows the calibrated results for all Lower Locus ^{14}C dates from *in situ* deposits between Paleosol 1 and stratum R4, ordered by depth and age within stratum. The analytical potential for investigating site structure and organization is almost unparalleled. To this end, occupation history was assessed.

Following the evaluation criteria outlined in Pettitt et al. (2003:1687-1690), each sample obtained and dated at Gerstle River were assessed. Each category of evaluation (n=9) has a total of 0-4 points from lowest confidence to highest confidence, resulting in a possible score from 0-36. Following Pettitt et al. (2003:1687, 1690), I differentiate scores from 0-9 (<40% confidence) with rejection, 10-26 (40-60%) with provisional acceptance with some caution, and 27-36

(>60%) with confidence. Each element of the evaluation is briefly described below, using Component 3 hearth feature dates (n=13) as an example. Various date assemblages relating to activity areas were then examined: Component 2 dates (n=2), Component 3 dates (n=13), and the Component 4 date (n=1).

Contamination by older/younger carbon and measurement of irrelevant carbon fractions is designated 1, as a C/N evaluation was not performed on these samples. ^{14}C dating of different chemical fractions based on material (i.e., wood versus bone) is designated 2, as all samples were of hearth charcoal that are consistent with other materials (in this case, bone) dated at the site. Accuracy is considered 4, as the samples date to less than 20000 BP, fall into a consistent stratigraphic sequence, and are calibrated with INTCAL98. The agreement of dated samples from the same stratum (Y4a and Y4b) is high, allowing a score of 4 for sample materials and ^{14}C measurement. Sample measurement and reporting is considered 5, where pretreatment, stable isotope data is reported, and the laboratory participates in International Radiocarbon Laboratory intercomparisons. The certainty of association of the dated samples with each hearth feature is considered 3, as there is a direct contextual relationship, though no culturally modified items are dated. The relevance of the dated samples to the hearths is designated 3, that is, a high probability of association, as the charcoal was directly within the hearth matrices. Finally, the quantity and nature of the dates within the Components 2, 3, and 4 strata (Y4b and Y4a) indicate different levels of certainty. Component 2 (stratum Y4b) has two feature dates that are statistically the same age at 2σ, thus resulting in a score of 1. Component 3 (stratum Y4a) has 13 feature dates, of which almost half are statistically the same age at 2σ, thus resulting in a score of 4. Component 4 (stratum Y4a) has one feature date, resulting in a score of 0.

None of the dates were assessed for outright rejection. All radiocarbon dates from the site (n=40) have an average score of 21.2±5.6, ranging from 14-28. All radiocarbon dates from secure *in situ* contexts (n=36) have an average score of 21.8±5.5, with the same range. All dates from the Lower Locus (n=25) have an average score of 24.1±4.8 and all dates from the Upper Locus (n=15) have an average score of 16.3±2.5. Secure stratigraphic dates from the Lower Locus (n=21) have an average score of 25.8±3.2. Component 2 dates (n=2) have an average score of 25±0. Component 3 dates (n=13) have an average score of 28±0. The Component 4 date has a score of 24±0. Using somewhat arbitrary and conservative criteria of Pettitt et al. (2003), the scores at Gerstle River (between 21.2 and 28.0) are relatively high, and they should be viewed as acceptable with some caution, except for Component 3 dates, which by the quantity and

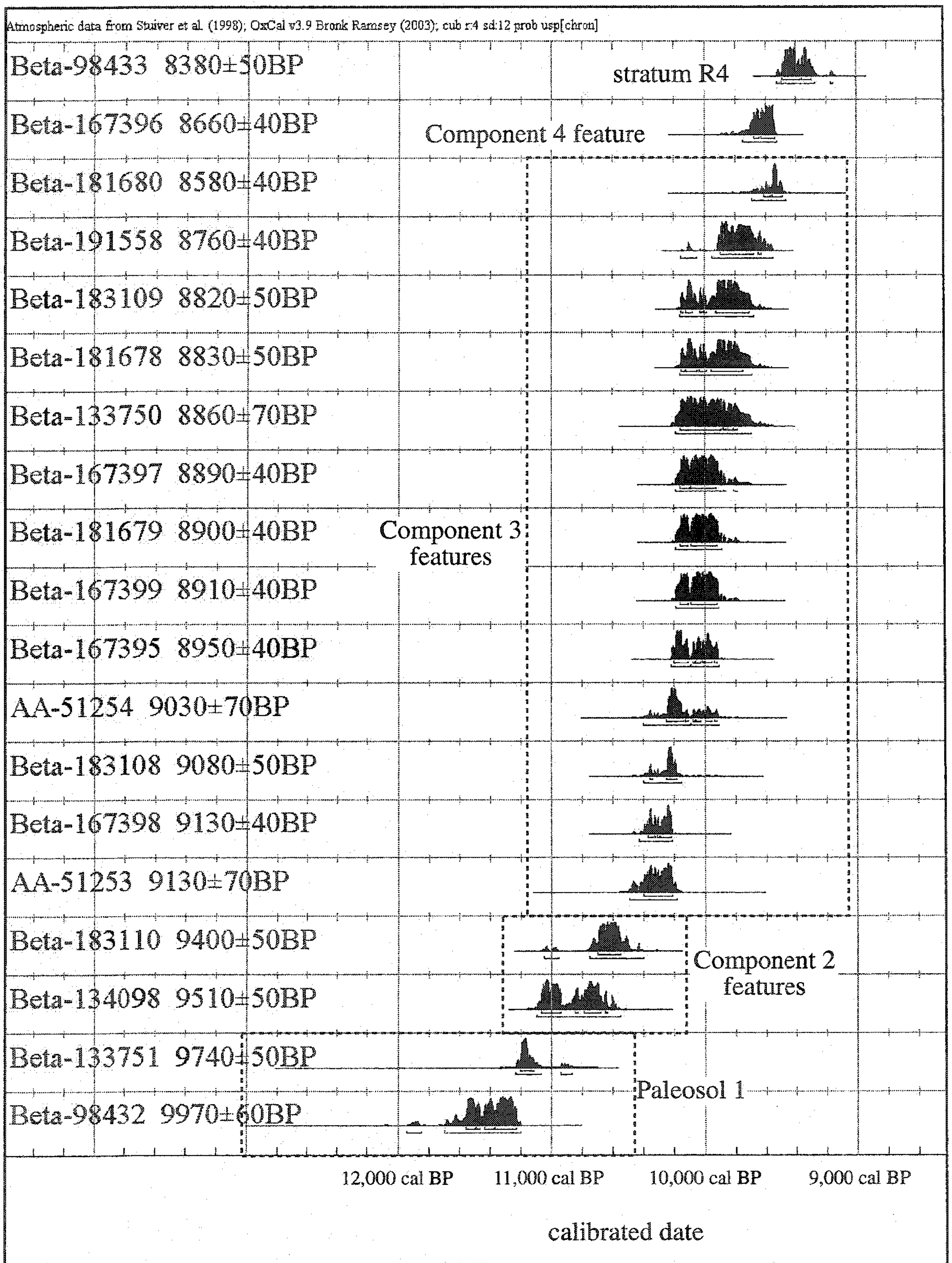

Figure 5.2 Calibrated results for all Lower Locus ^{14}C dates from *in situ* deposits between Paleosol 1 and stratum R4, ordered by depth and age within stratum.

secureness of provenience, reach the confidence level (see above).

Discussion

Contemporaneity and Homogeneity/Dispersion

As noted, all of the samples associated with cultural features within Component 3 all lie in stratigraphic sequence, between strata R3 (6239±51 BP) and Y4b (9449±41 BP). There are no stratigraphic layers within Y4a, which consists of an aeolian silt matrix. Y4a contains (a) 10 hearths or charcoal scatters associated with Component 3, about 16-25 cm below R4 in Areas B, C, and D, and about 25-37 cm below R4 in Area A, and (b) one hearth (Feature 7) associated with Component 4, between 8-12 cm below R4 in Area B. As Feature 7 was stratigraphically higher than the others in the area (Features 3, 5, 9) by about 8-10 cm, it was expected to date between the known Component 3 hearth (8860±70 BP) and the R4 date at the Lower Locus (8380±50 BP). All the other hearths were associated with Component 3, the only other component within Y4a and were expected to date to a similar period.

Table 5.4 provides the results of the pair-wise tests of contemporaneity (T' values), with boldface indicating no significant age differences (i.e., the null hypothesis is not refuted). Out of 78 possible bivariate relationships of the 13 dates, 38 (48.7%) indicate no significant differences in age (i.e., statistically the same date) at the 95% confidence level. The first Feature 14 sample (β-181680) is clearly divergent from the remaining 12 dates. The second Feature 14 sample (β - 191558) is more in line with the remaining dates, and is statistically the same (at 95% confidence) with three other hearths. β-167395 (8950±40 BP) is contemporaneous with most of the other dates (n=6). Clusters of contemporaneous dates are not apparent. An approximately normal distribution around a center date (β-167395) is evident. Another possible pattern is the division of two groups, one of dates older than 9030 BP (n=4) and the remaining dates (n=7). Another possible pattern is the division of three groups, one of dates older than 9030 BP, one of dates between 8860 and 8950 BP (n=4), and one of dates between 8760 and 8830 BP (n=3) (see section on occupation scenarios, below).

In order to assess homogeneity or dispersion within a series of radiocarbon assays, outliers must be identified first. Secondly, the results with acceptable ranges of homogeneity can be averaged (Ward and Wilson 1978), yielding a pooled average (A_p). Since similar treatment of

Table 5.4 Pair-wise tests (T' values) of contemporaneity of Gerstle River Component 3 feature dates. Shaded cells indicate contemporaneity (χ^2=3.84 at α=0.05).

	Feature 14 β-181680	Feature 14 β-191558	Feature 16 β-183109	Feature 12 β-181678	Feature 1 β-133750	Feature 5 β-167397	Feature 13 β-181679	Feature 10 β-167399	Feature 3 β-167395	Feature 9 AA-51254	Feature 18 β-183108	Feature 8 β-167398	Feature 11 AA-51253
Feature 14 β-181680	—												
Feature 14 β-191558	5.58	—											
Feature 16 β-183109	9.83	0.61	—										
Feature 12 β-181678	10.62	0.83	0.02	—									
Feature 1 β-133750	9.35	1.19	0.19	0.11	—								
Feature 5 β-167397	19.01	3.32	0.95	0.70	0.12	—							
Feature 13 β-181679	20.29	3.85	1.25	0.95	0.21	0.02	—						
Feature 10 β-167399	22.41	4.59	1.64	1.29	0.33	0.10	0.02	—					
Feature 3 β-167395	26.92	7.04	3.26	2.77	1.05	0.82	0.57	0.38	—				
Feature 9 AA-51254	24.94	8.93	5.37	4.86	2.69	2.65	2.28	2.00	0.86	—			
Feature 18 β-183108	44.34	18.03	11.80	10.86	5.86	7.33	6.59	6.11	3.41	0.31	—		
Feature 8 β-167398	61.62	27.65	19.21	17.91	9.69	13.72	12.63	12.10	7.66	1.38	0.52	—	
Feature 11 AA-51253	36.85	16.59	11.58	10.81	6.73	7.68	7.06	6.63	4.30	0.95	0.31	0.00	—

samples is recommended, assays from the same laboratory are generally more comparable. Since most of the assays are from Beta Analytic (see above), that is not further considered. The search for outliers requires an actual assumption of contemporaneity, which is supported on contextual grounds, is strongly (but not absolutely) supported by the radiocarbon dates.

Table 5.5 presents the results of the tests of contemporaneity within and among areas and Components 2 and 3. All dates were tested by Area. All features within Area B (n=4) were contemporaneous at 95% confidence level. All features within Area C (n=4) were not contemporaneous. When the charcoal scatters (Features 8 and 11) were removed, the two hearths (Features 12 and 18) were not contemporaneous. Hearth Feature 18 and charcoal scatters Features 8 and 11 were contemporaneous. All features within Area D (n=3, combining both dates on Feature 14) were not contemporaneous. The two Feature 14 dates were not contemporaneous. However, when all three features were tested, excluding the younger Feature 14 date (β-181680), they were contemporaneous.

Potential contemporaneity among the areas was also examined. Areas A and B were contemporaneous. Areas A, B, and D (without the anomalous Feature 14 date) were contemporaneous. Finally, Areas A, B, D (as defined above), and C (Feature 12) were contemporaneous (n=9 features).

Comparisons at the level of Component 3 were examined. All dates (n=13) combined were not contemporaneous. Removing the anomalous date from Feature 14 did not affect the outcome. Removing the charcoal scatter features (Features 8 and 11) did not render the remaining features contemporaneous, (T'=26.98 versus χ^2=16.90). After removing these three dates and the Feature 18 date (β-183108), the remaining features were contemporaneous. Pooling the 9 contemporaneous feature dates of Component 3 yields an average of 8882±17 BP (T'=14.23 versus χ^2=15.50). Figure 5.3 illustrates the combined averages of Areas A, B, C, and D and Component 3 under the conditions described above.

Table 5.5 Radiocarbon tests of contemporaneity within and among areas.

Group	*Assays*	$A_p \pm V(A_p)$	*T' (χ^2 critical value)*	*Contemporaneous (α=0.05)*
Comparisons within Component 3 Areas				
Area B, all	8860, 8890, 8950, 9030	8938±28 BP	3.71 (7.81)	Yes
Area C, all	8830, 9080, 9130, 9130	9044±27 BP	20.77 (7.81)	No
Area C, all except charcoal scatters	8830, 9080	8960±38 BP	10.86 (3.84)	No
Area C, Features 8, 11, 18	9080, 9130, 9130	9113±31 BP	0.59 (5.99)	Yes
Area D, all	8580, 8760, 8820, 8900	8756±25 BP	26.59 (7.81)	No
Area D, Feature 14	8580, 8760	8653±34 BP	6.60 (3.84)	No
Area D, all except 8580 BP	8760, 8820, 8900	8834±30 BP	3.95 (5.99)	Yes
Comparisons among Component 3 Areas				
Areas A, B	8860, 8890, 8910, 8950, 9030	8923±24 BP	3.83 (9.49)	Yes
Areas A, B, D (except 8580 BP)	8760, 8820, 8860, 8890, 8900, 8910, 8950, 9030	8888±18	13.21 (14.10)	Yes
Areas A, B, D, (except 8580 BP), C (Feature 12)	8760, 8820, 8830, 8860, 8890, 8900, 8910, 8950, 9030	8882±17 BP	14.23 (15.50)	Yes
Comparisons at the Component 3 Level				
All C3	8580, 8760, 8820, 8830, 8860, 8890, 8900, 8910, 8950, 9030, 9080, 9130, 9130	8901±14 BP	114.68 (21.00)	No
All C3 removing Feature 14 date of 8580 BP	8760, 8820, 8830, 8860, 8890, 8900, 8910, 8950, 9030, 9080, 9130, 9130	8938±15 BP	56.75 (19.70)	No
All C3, removing Feature 14 date of 8580 and those from charcoal scatters (Features 8 and 11)	8760, 8820, 8830, 8860, 8890, 8900, 8910, 8950, 9030, 9080	8902±17 BP	26.98 (16.90)	No
All C3, removing Feature 14 date of 8580, those from charcoal scatters (Features 8 and 11) and Feature 18	8760, 8820, 8830, 8860, 8890, 8900, 8910, 8950, 9030	8882±17 BP	14.23 (15.50)	Yes
Comparisons at the Component 2 Level				
All C2	9400, 9510	9449±41 BP	1.77 (3.84)	Yes

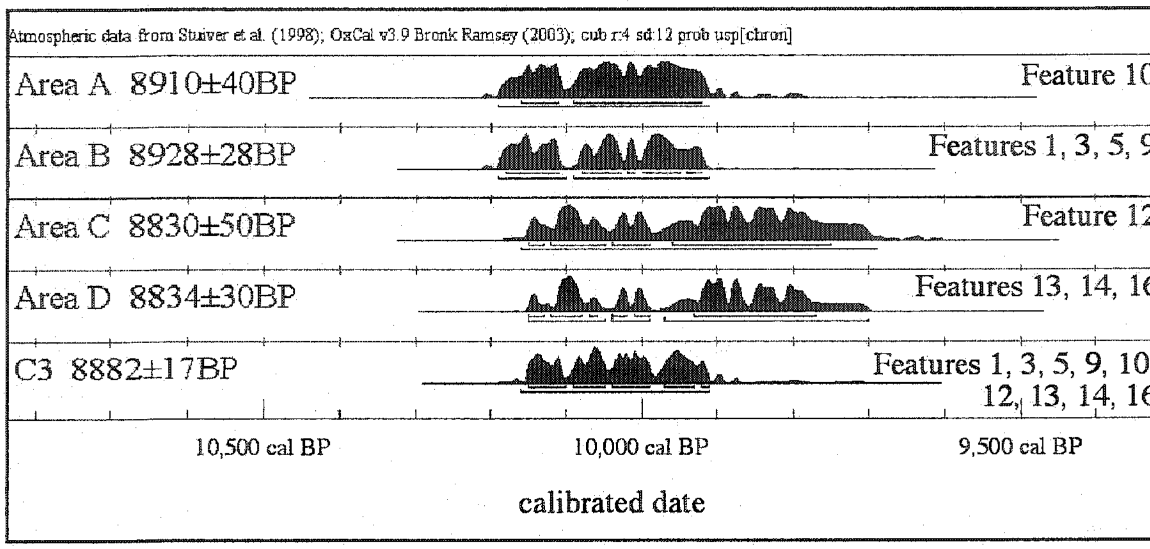

Figure 5.3 Calibrated pooled averages by area and Component 3.

Figure 5.4 illustrates all Component 3 dates after calibration. Two and three σ are represented by lines underneath each date's probability distribution. The mean date (after calibration) for nine of the 12 features is shown on Figure 5.4 as a shaded bar representing 2 σ. Since the contemporaneity tests were based on uncalibrated radiocarbon ages, the calibrated date ranges should provide a more accurate illustration of the actual age probabilities. Comparing calibrated dates is difficult, as the distribution after calibration is non-Gaussian (see Hedges 2000), so the application of a χ^2 test similar to that described above is untenable. However, probability distributions of 2σ (i.e., 95% confidence limits) can be compared. After calibration, the 13 Component 3 feature dates were examined for overlap at 2σ with the weighted average 8882±17 BP, calculated from all Component 3 dates except β -181680, β -183108, 167398, and AA-51253 (see above). All dates overlapped at 95% with the exception of β-181680, β -167398, and AA-51253. The Feature 18 date (β -183108), considered an outlier in the analysis of the uncalibrated conventional dates, overlaps at 2 σ, suggesting that all hearth features (including Feature 18) may be contemporaneous.

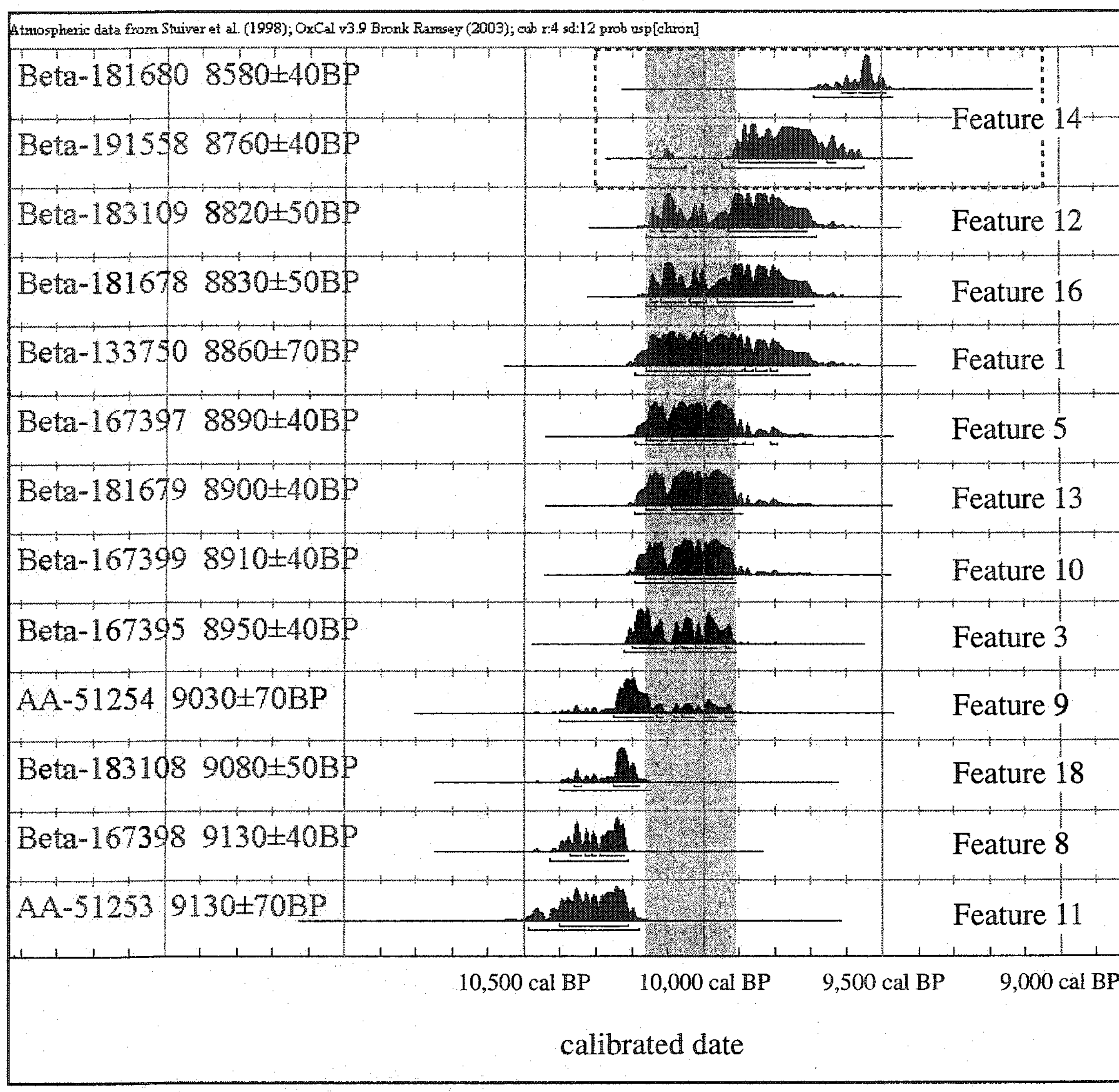

Figure 5.4 Calibrated results for all Component 3 ^{14}C dates, ordered by age. Lines under distributions represent 1 and 2 σ. Shaded bar represents 2 σ of the mean date for all features except Features 8, 11, and 18.

Rejection of Outlying Dates

Outliers Relating to Site Chronology

At the Upper Locus, of the 14 samples yielding dates, 6 of these are rejected given current documentation (42.8%); however one date (3390 BP) may be associated with Y1 instead of R2 (in Test Pit 5, R1 and R2 coalesced with only discrete lenses of Y1. Another three (reported in Kimura et al. 1989) have limited provenience information available (see above and Potter 2002 for detail). Therefore, only two dates with securely documented stratigraphic provenience are clearly rejected for the Upper Locus, a date of 2110 BP on Y2 and 6470 BP on Y4a. The resulting rejection rate (14.3%) is lower than other reported rejection rates (33.3% from Shott 1992, 28.8% from Dean 1991).

At the Lower Locus, of the 25 samples yielding dates, one has no clear recorded stratigraphic association, other than "Bluff face paleosol, not correlated" (Holmes 1998a:16). Three dates are from bones on the slope surface (OxA-11246, OxA-11962, β-109267). The remaining 21 dates are all consistent with the stratigraphic order at the site, with no reversals by strata, and none can be rejected outright on the basis of departures from the general stratigraphic sequence (see above).

Outliers Relating to Occupation History

There are no *a priori* reasons to reject any of the dates on *in situ* materials in association with archaeological remains at the Lower Locus (n=16, see above). The series of pair-wise and group-wise tests of contemporaneity (see Tables 5.4 and 5.5) show that the majority of dates from Component 3 (n=9) cannot be statistically distinguished (at 95% confidence). However, one date is considered to be anomalously young, and three dates are considered to be anomalously old. These four are considered here.

The β-181680 date (8580±40 BP) on Feature 14 could reflect perturbations in the ^{14}C calibration curve in the early Holocene. At the Mesa site, dates on a single hearth ranged from 10,260±110 BP to 9850±150 BP (Kunz et al. 2003:19). The probable underestimation of standard error (see above) and the near contemporaneity of the two Feature 14 dates (T'=5.58, slightly greater than critical χ^2 value of 3.84) both support the possibility that the dates are not significantly different. The second sample, β-191558, is more in line with the other Component 3 dates (see Table 5.5 and Figure 5.4), and the first was provisionally discarded pending further dates on Feature 14.

The two dates from charcoal scatters interspersed with artifacts and faunal remains, β-167398 (Feature 8) and AA-51253 (Feature 11), are contemporaneous with a number of features with dates more similar to the main group (n=9), like Features 18 and 3. The fact that these features are not fully oxidized hearths with lenticular cross-sections (i.e., they are more ephemeral features), the confidence in the direct association between the dated samples and the target events, i.e., deposition of the lithic artifacts, is slightly reduced.

The final anomalous date, β-183108 (Feature 18), overlaps at 95% confidence with Features 3, 9, and 13. If the standard error slightly underestimates the actual error (see above), this date may be contemporaneous with more of the Component 3 features. Once the dates are calibrated, this date is contemporaneous at 95% confidence with the pooled average of the contemporaneous Component 3 dates (n=9). In other words, this date is at the very limit of contemporaneity with the majority of the Component 3 dates, suggesting that there is a strong possibility it may in fact be contemporaneous.

Component 3 Occupation Episodes

Radiocarbon data does not exist in a vacuum, but within contextual datasets. As discussed above, several classes of data provide evidence for contemporaneity at Component 3. Hearth features generally have clear, distinct boundaries. There is no evidence of multiple hearths or significant smearing or scattering of charcoal or associated oxidized sediments suggesting post occupation disturbance or re-occupation. There are no other strongly oxidized areas in Y4 with the exception of the hearth features. The hearths were unlined, roughly circular in plan view, and biconvex or lenticular in cross section. No features overlap one another. The distinctive character of the microblade technology (technological tradition) is found in all Areas in Components 2 and 3. The faunal assemblages are relatively homogeneous across Component 3, namely wapiti and bison burnt and unburnt remains. There are no specific areas where only one or the other were found, with the possible exception of the possible dump in Block J. The lithic raw material type distributions strongly support contemporaneity within each Area and potentially across the site. Each Area has numerous material types, and a distinction based on patterning in material types among Areas cannot be inferred. The features are patterned in relation to each other in such a way as to at least suggest site organization. In other words, within each Area the hearths are spaced at relatively even intervals, not randomly across the site. The aggregation of the hearths is itself a pattern that suggests contemporaneity. An alternate hypothesis could be that each Area was occupied separately, and were placed as to avoid earlier hearth/activity areas. In summation, the number of occupation episodes suggested by the extra-radiocarbon evidence suggests that the deposition of the material within Component 3 was from a single occupation, or very few occupations at close temporal spacings, perhaps seasons of subsequent years.

Component 3 Occupation Span(s)

Ethnographic and ethnoarchaeological data can be used to infer occupation spans at Components 2, 3, and 4 at Gerstle River. Behaviors related to hunting camps are patterned relative to natural and social processes as well as exigent circumstances (cf. Binford 1978b, 1983a; Kent 1984; O'Connell 1987). Assuming hearth areas were occupied simultaneously and flintknapping each material type occurred at the same time, a minimum span of a single day could be inferred. Conservative scenarios for occupation span for Component 3, that is, the total length of time spent on the site, includes (1) a single day (or a few hours) by a large group (n>10 people), and/or (2) intermittently over the course of a few days or weeks within a season within a year, and/or (3) intermittently over the course of a few days within a season over a span of years.

Gerstle River Component 3, where activities like game processing, lithic maintenance, and making and tending fires for a wide variety of purposes (cooking, heating, etc.), was not likely occupied continuously for any length of time (greater than a few days). There is no accumulation of debris (middens) that would suggest a more permanent residence. There is no evidence of houses or structures suggesting longer stays or winter occupations. The low tool diversity compared with other components (such as Healy Lake, Tuktu and Athabaskan levels) suggests that domestic activities did not play a large part in the Gerstle River Component 3 activities.

Component 3 Occupation Scenarios

On the basis of the radiocarbon results analyzed above, there are several Component 3 occupation scenarios that can be outlined. These scenarios are developed only on the basis of temporal occupation, hearth creation and use, with Area being the smallest spatial unit. Activities are not further defined or differentiated for each occupation or Area. In each of these scenarios, the occupation history is different, and the identities of the people are not further defined (i.e., the same group or band, or a different band), however they did utilize the same technology. Factors that may vary include number of areas occupied simultaneously, number of hearths created and used simultaneously, number of lithic raw material types (n=20) that were deposited, and/or lithic raw material type clusters (n=63), among others. On the basis of these three data sets, a wide variety of permutations is possible. Out of these numerous scenarios, five scenarios are selected on the basis of plausibility and conformity with the radiocarbon and other classes of evidence.

Three broad classes of scenarios relate to (A) single occupation, (B) multiple (short-term) occupations, and (C) multiple (long-term) occupations.

Scenario A. The simplest scenario is that all Areas were occupied at the same time. This hypothesis cannot be refuted on the basis of the currently available radiocarbon dates. Tentative support for the potential of occupation of the site can be sustained by the other data classes. This scenario has all ten hearths of Component 3 occupied and used simultaneously and not re-used at a later date.

Scenario Group B. Multiple occupation (short-term) scenarios are many and diverse. These scenarios have two or more occupations, separated by days or weeks, occupying the same or different Areas.

Scenario B1. One possible scenario is that the first occupation occupied Area C, where Hearth Feature 18 (and possibly Features 8 and 11) was created. The second occupation then occupied Areas A, B, D, and re-occupied C, where Hearth Feature 12 was created. The charcoal scatters Features 8 and 11 may have been created when later occupants removed partially burned material from Hearth 18.

Scenario B2. This scenario would have each Area occupied at a different time, perhaps separated by one or a few seasons or years. Area C may have been occupied first, then Area B, then Area A, and finally Area D. Other variations could be postulated.

Scenario B3. Another group of scenarios would have different hearths within each Area created simultaneously over different seasons or years. For instance, Hearth 9 (Area B), Hearth 18 (Area C), and Hearth 13 (Area D) may have been occupied at one time. Later, people may have re-occupied each area and constructed a different hearth, Hearth 1 (Area B), Hearth 12 (Area C), and Hearth 16 (Area D).

Scenario Group C. This group of scenarios has multiple occupations at Gerstle River Component 3, separated by several years or more, but less than ~80 years, (based on sediment influx rates). A specific version of this scenario type would have hearth creation and use based exclusively on radiocarbon assays. Grouping the hearths into as few occupations as possible, would yield 3 occupations: (1) Features 8, 9, 11, and 18 creation and use (Areas B and C), (2) Features 1, 3, 5, 10, and 13 creation and use (Areas A, B, and D), (3) Features 12, 14, and 16 creation and use (Areas C and D).

Of all these scenarios, it is suggested here that occupations at a higher resolution than Area cannot be demarcated. The spatial positions of the lithic clusters, the features, and the faunal remains, the lack of trampling evidence or feature smearing suggests that each Area was occupied simultaneously, at least. Therefore, Scenarios A, B1, and B2 seem partially supported by the various evidence classes, with the first two with higher confidence. It is suggested here that Scenarios A and B1 cannot be distinguished on the basis of the radiocarbon evidence. These scenarios are addressed further in Chapters 10 and 11, where flotation samples, macrofossil analysis, lithic artifact cluster analysis, various technological analyses, and faunal analysis are integrated within the chronological framework established here.

Remaining Ambiguities

The radiocarbon dating program at the Gerstle River site has yielded a variety of data that can be used in establishing and supporting a site chronology and for discriminating among different occupation scenarios. However, a few ambiguities remain to be examined by further radiocarbon testing.

The foremost problem is building a stronger database for each component and natural strata. Each hearth feature should be dated with a minimum of four samples in order to control for inherent variation in radiocarbon analysis (see above). Further excavation in Area D will likely elucidate samples in close association with Component 5 artifacts or possible features.

Excavation to the east of Areas B and C may enable recovery of samples with secure association with Component 1. Each strata should be dated. Several strata are currently dated with only one assay, and these should be the first priority over those with two or more dates. The sequence of dates on stratum R4 and below at the Upper Locus will be enhanced by further testing and careful collection of samples there.

The relationship between bone and charcoal associated with the cultural features and artifacts should be examined. At present, none of the Component 3 fauna have been directly dated. Component 3 offers an excellent testing base for assessing results from different material types with clear stratigraphic and horizontal association.

Hearth Feature 18 (and possibly Feature 9) and charcoal scatter Features 8 and 11 may reflect an earlier occupation. Further excavation in Area C and collection of carefully controlled ^{14}C samples will be useful for evaluating this hypothesis. I have incorporated this into future plans for excavation at Gerstle River.

CHAPTER 6. FAUNAL ANALYSIS

Introduction

The presence of well preserved faunal remains in close association with cultural features and lithic artifacts is extraordinarily rare in Alaska, especially in the Late Pleistocene/Early Holocene. There are only four sites in Alaska where this kind of preservation and association has been found: Broken Mammoth, Gerstle River, Swan Point, and Mead. These four sites constitute 18% of the 22 sites with components older than 7000 BP, and less than 0.1% of the 2856 prehistoric sites in Interior Alaska (Potter 2004b). At present, no detailed analyses have been published for Broken Mammoth and Swan Point (see Holmes 1996; Holmes et al. 1996) and Mead has only received limited testing (12 m^2, Holmes 1999, unpublished Mead Site database). Other sites in this time period have small quantities of preserved faunal remains, such as Dry Creek Component 1 and 2, but faunal remains are typically poorly preserved (Powers et al. 1983). Therefore, the analysis that follows is the first detailed analysis of a Late Pleistocene / Early Holocene archaeologically derived faunal assemblage in Alaska with a high degree of preservation, and comparisons must be drawn from other areas, such as Paleoindian and Late Prehistoric sites from lower North America.

In this analysis, I strove to maximize the potential for developing new avenues of examining faunal assemblages, especially those of Paleolithic ages. That portion of every faunal assemblage constituted by "unidentified fragments," is often subjected to relatively brief further analysis of narrow scope or ignored altogether (cf. Klein and Cruz-Uribe 1984:17). In the Gerstle River Component 3 assemblage, these unidentified fragments (unidentified with respect to taxon or element portion) constituted 29% of the total weight and 83% of the total number of fragments. This substantial portion of the assemblage is addressed using a variety of analyses and variables. It is recognized that not all variables may be equally important in predictive or associative value with certain behaviors, and not all relationships may be predicted or interpreted on the basis of extant actualistic or experimental research, however patterns among variables that conceivably could be related to hunting or processing behaviors were examined. To this end, the analysis presented here focuses on presenting the data in various forms in order to describe patterning within the assemblage.

A total of nine distinct faunal assemblages are present at Gerstle River Lower Locus, and were demarcated on the basis of provenience (stratigraphic position, direct association with cultural components, and associated radiocarbon dates). These assemblages are Component 1 (stratum Y5a), Component 2 (stratum Y4b), Component 3 (stratum Y4a), Component 4 (stratum Y4a), Component 5 (stratum Y3), stratum Y2, Block W, Subsurface – non-cultural, and disturbed fauna. Faunal remains are directly associated with Components 1, 2, 3, 4, and 5. In addition, faunal remains within stratum Y3 in areas further away from cultural materials may also be associated with Component 5 and are combined for this analysis. Faunal remains associated with stratum Y2 may relate to Component 6 (from the Upper Locus), and are combined for this analysis. Faunal remains found *in situ* within Block W, nine meters southwest of the main excavation area are analyzed separately due to lack of stratigraphic correlation with the main chrono-stratigraphic model (see Chapter 4). Four groups of faunal remains found *in situ* but not associated with cultural artifacts or features are discussed in the "subsurface, non-cultural" section below. These include materials associated with (1) strata III-VII sands, (2) stratum Y5b, (3) gastropod shells from Y4a (30-40 cm below R4), and (4) small mammal remains found in stratum Y4a (20-30 cm below R4). The final assemblage considered consists of those remains from disturbed contexts, surface or subsurface (overburden), including materials collected from 1996-2003 at the Lower Locus. While faunal remains from stratum Y5b and Block W may be associated with Component 1, they are discussed separately because there were no cultural materials in association with either of these assemblages, and they do not lie within the exact stratum where Component 1 cultural materials have been recovered (stratum Y5a).

Component 3 is treated as a single faunal assemblage for a number of reasons. First, very few species are represented, essentially wapiti (a.k.a., red deer or elk, *Cervus elaphus*) and bison (steppe bison, *Bison priscus*, see below) with one worked mammoth tusk fragment. Second, weathering and bone condition is very similar throughout the component. Third, there is clear spatial association with lithic concentrations and hearth features that are contemporaneous or nearly contemporaneous (see Chapter 5).

The entire faunal assemblage from the Lower Locus excavations (1999-2003) and from the 1996 surface collections and Bluff Test Pit is presented in Table 6.1. The only faunal material at the Gerstle River site excluded from this analysis are fauna recovered from the Upper Locus and the surface of the Lower Locus prior to 1996. The faunal sample is almost certainly incomplete for the major components (Components 1 through 3) given the eroding bluff edge and the presence of faunal remains adjacent to unexcavated areas. However, the sample is likely complete for several intra-component areas given the spatial distribution (see Figures 6.9-6.13).

Table 6.1. Gerstle River Lower Locus faunal assemblage summary (1996-2003).

Assemblage	*Number of provenience units*	*Number of fragments*	*Total weight (g)*	*NISP*
Component 1	22	35	7.5	3
Component 2	4	10	1.9	1
Component 3	768	4224	12068.7	192
Component 4	17	149	82.4	0
Component 5 (stratum Y3)	19	42	491.6	21
Stratum Y2	14	29	964.3	20
Block W	14	59	257.1	1
Subsurface, non-cultural	17	63	27.6	15
Disturbed	224	908	11196.7	138
TOTAL	1099	5519	25097.8	391

Because the research potential is different for each assemblage, they are analyzed in different ways. The main portion of this chapter deals with Component 3, and detailed faunal and spatial analyses are presented. Analyses for faunal remains from other assemblages consisted of size class, taxonomic class, taxa, burning type, weathering, faunal shape, and spatial patterning (except for material not associated with cultural remains and disturbed fauna). Specific research questions are detailed in the next section.

Problem Statements

Paleolithic archaeological components with limited post-occupation disturbance are extremely rare, and only a few have been accepted without some critique (Audouze and Enloe 1997; see review of Paleolithic living floors and critiques in Dibble et al. 1997:630-632). Given the high resolution in spatial patterning within Component 3, there are a number of site structural, site organizational, and site functional problems that can be addressed through faunal analyses. These problems are complicated and are interlinked in many ways, but are presented as five clusters of research questions, (1) spatial patterning, (2) taphonomy, (3) butchering and processing model, (4) faunal trajectories, and (5) site function.

Spatial patterning among the faunal remains is examined through the identification and evaluation of faunal spatial clusters and their co-occurrence with lithic concentrations and features. Evidence for areas of primary and secondary processing and disposal (bone dumps) are evaluated.

Potential post-occupational and post-depositional taphonomic processes are evaluated. Carnivore accumulation, carnivore and rodent scavenging, weathering, and sedimentation are considered as possible taphonomic agents in the formation of the faunal assemblage.

A spatially integrated model of butchering and processing activities is developed on the basis of various datasets, including spatial patterning data, fragmentation, size, shape, and skeletal part frequency analysis. Expectations based on a kill-site and camp/butchering site assemblages are tested against the data. Similarities in differences in how wapiti and bison are butchered and processed are examined. Potential causes for the relative lack of axial elements, such as differential transport off-site or differential on-site destruction/fragmentation are explored. Expectations based on different types of marrow extraction and bone grease rendering are examined.

Developing faunal trajectories involves describing movements of anatomical portions through the site, from introduction through processing and ultimately to discard or transport off-site. The integrity of faunal remains in Component 3 range from articulated specimens to scattered small fragments. It is clear from the analysis presented below that whole carcasses were not brought to the site. Potential anatomical portions introduced to the site and/or removed from the site are considered.

The integration of the spatial butchering and processing model and faunal trajectories along with basic faunal data analysis will enable an inquiry into problems requiring more indirect inference. These data are used to assess single or multiple processing events on site. Contemporaneity of the faunal clusters is assessed. Seasonality of the occupation(s) is estimated and mortality profiles for the animals exploited at the site (age and sex) are presented. Food availability and diet preferences, hunting strategies and occupation number and size are explored.

Different types of faunal assemblage data are needed to address these problems, including NISP, MNE, MNI, MAU, %MAU calculation, spatial analysis, faunal weight, density, fragmentation, faunal shape, burning, long bone shaft and end distributions, taxa distribution, skeletal unit types, weathering, articulation, refitting, skeletal part frequency analysis (including element deletion, bone density and %survivorship, and utility indices), seasonality, age estimation (epiphyseal fusion of long bones, dental annuli, tooth eruption, and tooth wear), and sex estimation.

Methods

Excavation and Laboratory Methods

Excavation methods relating to faunal remains are briefly described here; further details are provided in Chapter 2. Sediments associated with Components 1, 2, 3, and 4 and Block W were screened through 1/8" screens. Strata Y3 (Component 5) and Y2 were screened through 1/4" screens prior to 2003, and 1/8" screens during 2003. All large faunal fragments (generally >3 cm) were mapped in their *in situ* contexts with detailed plan drawings. Faunal remains were recovered and catalogued on the basis of unique provenience, based on screening of sediments in 0.25 m^2 units or 3-pointed coordinates. Each field specimen number is based on a specific location, corresponding largely to deposition (see Chapter 4), and perhaps retaining meaningful information relating to discard or butchering/modification behaviors (see below). It is impossible in some cases to determine if all fragments within an individual field specimen originally belonged to the same element(s), but given morphology and spatial distribution, most of the field specimens likely represent single element portions. For the purposes of this analysis, the term *provenience unit* is used for each field specimen. In the rare instance when two diagnostic specimens were found within one field specimen, they were given two catalog numbers, except for articulated elements, which were kept within a single catalog number. When two diagnostic specimens from different field specimens refit or were from the same element, they were not combined into one catalog number. For skeletal elements, each provenience unit is roughly equivalent to one NISP. For Component 3, 176 of the 768 associated faunal provenience units contained one or more identifiable specimens, resulting in an NISP of 192.

Once the faunal remains were in the laboratory, all field specimens were entered into the computer database. Bone and enamel were separated from lithics and charcoal for screened field specimens. Hearth matrix bulk samples were the only exception, where they remained separate for flotation and future analysis. Bones were lightly brushed with soft pliant natural-haired brushes to remove sediment and rootlets. Tweezers were used to remove some rootlets. If the remains were excessively fragile, or longitudinal cracks appeared, a light, thin coat of diluted water-soluble polyvinyl acetate (PVAC) based adhesive (Elmer's™ Glue-All) and water (roughly 1:5) was brushed on the specimen(s) with a clean, dry, pliant brush. I did not attempt to re-connect fragmented remains except where fresh breaks were apparent indicating breakage during or after recovery. In this case, the bones were re-connected with undiluted PVAC-based adhesive. None of the remains were soaked in water. Faunal remains were air-dried, weighed, and the fragments were counted (see below). Some faunal materials were photographed with 35 mm color film or through digital photography. Fragile remains were generally wrapped in clean acid-free tissue to absorb any remaining moisture, and placed within an aluminum foil shell, folded to keep the fragments in their relative positions upon discovery.

During the cleaning process, the faunal remains were identified to the highest possible resolution of taxonomy and element category. Taxonomic categories ranged from the class level (Aves, Mammalia) to the specific level (*Bison priscus*, *Cervus elaphu*[1]*s*). Identifications were made through comparative collection of bison, wapiti, moose, and caribou obtained from the University of Alaska Mammalogy Laboratory and the Department of Anthropology, and with the aid of various comparative guides (Bass 1987; Brown and Gustafson 1979; Gilbert 1993; Gilbert et al. 1985; Glass 1973; Hillson 1992; and McGowan and Bengston 1997; Schmidt 1972; Todd 2004; van Zyll de Jong 1986). Sorting, identification, sexing, aging, and measurement methods generally follow Klein and Cruz-Uribe (1984) except where noted below. Each fragment was also examined for possible human, carnivore, or rodent modification such as cut marks, impact or puncture marks, or gnawing damage.

Coding

Each faunal specimen was examined for a number of coded variables that were described by provenience unit. This can result in multiple codes per field specimen. Each variable is described below.

<u>Size class</u> was estimated on the basis of species, element, and/or size and thickness and were classed as *VS* (<100 g total mammal weight, e.g., mouse, vole), *S* (100-700 g, e.g., squirrel,

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[1] Mitochondrial DNA analysis on two bison bones from disturbed contexts dating to c. 9500 BP indicated that the bison were *Bison priscus*. Wapiti (*Cervus elaphus*) is the only species of this genera in the size range of the Gerstle River specimens in northwestern North America.

rat), *M* (0.7-25 kg; e.g., hare, fox, porcupine), *L* (25-84 kg; e.g., wolf), and *VL* (>85 kg; e.g., bear, wapiti, bison, moose) (modified from Thomas (1969)).

Taxonomic class was estimated on the basis of species, element, and/or bone size and thickness and were classed as *Mammalia, Aves, Other*, or *Indeterminate.* Taxon was estimated on the basis of comparative collections and various comparative guides (see above). Taxa included genera (*Cervus, Bison*) as well as higher taxonomic levels (Cervidae, Ungulate).

Element portion was assigned on the basis of element and portion of element (Gifford and Crader 1977), excluding the segment of the portion, given the small sample size.

Side was classed as *right, left, axial*, or *indeterminate.*

Breakage type was classed as *complete, cylindrical, generic, longitudinal*, and *transverse* (generally following Marshall 1989).

Degree of epiphyseal fusion (Fusion) was classed as *unfused, partially fused, fused*, or *indeterminate.*

Burning type was classed as *white charred, black charred, brown charred, possibly burned, not burned*, and *indeterminate.* This was coded for all of the fragments within each provenience unit. Predominant burning type was coded as a single class for the majority of the fragments within each provenience unit (by weight). Burning was a derived variable with white charred, black charred, brown charred, and red charred classed as *burned*, and possibly burned, not burned, and indeterminate classed as *unburned.*

Weathering stages for each bone were not systematically recorded, as they generally poorly preserved, ranging from Stage 4-5, with very few at Stage 3 (see Todd et al. 1987; Behrensmeyer 1978). Weathering type was recorded for each fragment, and included *bleached, surface flaking, mosaic cracking, longitudinal cracking, erosion, vegetation, root etching, mineral deposits*, and *indeterminate.*

Completeness was classed as complete or near complete (*C*), distal end and estimated percent of diaphysis (*D#*), epiphysis and estimated percent of diaphysis (*E#*), proximal end and estimated percent of diaphysis (*P#*), distal epiphyis (*DE*), proximal epiphysis (*PE*), and unknown (*U*).

Faunal shape (Shape) was classed as unidentified bone frag (*1*), long bone fragment (*2*), flat bone fragment (*3*), short/irregular bone fragment (*4*), and tooth/enamel (*5*). Maxilla and mandible fragments with both bone and teeth were classed as *5*.

Weight was measured per provenience unit in grams (g) to the nearest 0.1 g, with individual diagnostic fragments weighed separately and teeth/enamel weighed separately from bone. Fragments weighing <0.1 g were estimated at 0.1 g for further analysis.

Maximum and minimum dimensions were measured in cm on the largest bone fragment within each provenience unit. If the largest fragment was less than 0.3 cm, then it was estimated at 0.1 cm for further analysis. Maximum dimension was measured as the maximum length of the longest dimension, or in the case of long bones, length of the diaphysis. Minimum dimension was measured as the maximum length of the shortest dimension, or in the case of long bones, the maximum width of the diaphysis. If bone and teeth are present within a provenience unit, then only the bone was measured; teeth were measured separately. Very tiny fragments (bone cheese or bone smears) were given values of 0.1 cm for maximum and minimum dimensions (N=33 provenience units, 4% of total). By only measuring the largest fragment within each provenience unit, these variables likely overestimate the total mean maximum and minimum dimensions, but this can allow for comparisons across the site without measuring every tiny fragment.

Number of fragments is derived from a total count of those fragments greater than 0.3 cm in maximum dimension for each provenience unit. When original observation notes indicate "many" fragments, the number of fragments is estimated at 30 if total weight of the lot is ≥0.2 g, and 1 if total weight of the lot is <0.2 g. This occurred in 20 provenience units with a total weight of 3.6 g (3% of the total Component 3 fauna by provenience unit and 0.03% by weight).

Skeletal Unit Type is classed as *Lower Limb* (3rd phalanx to tarsals/carpals), *Upper Limb* (distal radius-humerus to scapula and distal tibia to proximal femur), *Axial* (includes cranium, vertebra, ribs, innominates, and sacrum), and *Teeth* (includes mandible and maxilla fragments). Skeletal Unit Type 2 is similar to skeletal unit type, except teeth are combined with axial to form the *Axial* category and lower and upper limbs are combined to form the *Appendicular* category.

Sample Considerations

The Component 3 sample consists of 100% of all excavated bones within the component. A valid question is how well this sample represents the occupation(s) with respect to site function and ungulate exploitation. The living surface(s) have been truncated by the eroding bluff edge to the south and the excavation limits to the north and east. Given the distribution of faunal remains in Component 3, the bone scatters are expected to continue to the east in unexcavated areas.

However, clear boundaries for the bone scatters have been observed west and northeast of Feature 1, between Features 3 and 5, between Features 1 and 5 and between Features 9 and 12. Given the attention to excavating a large contiguous block area that encompasses the features and adjacent lithic and bone concentrations and the nature of the recovered remains, I believe that enough faunal material exists to develop and test scenarios of site function and ungulate exploitation within Component 3. The faunal assemblages associated with Components 1, 2, 4, and 5 are small, but are considered to be enough to generate basic descriptions given the nearly complete scatters of features and lithic artifacts (Areas E, F, G, and K). The faunal assemblages associated with Block W, subsurface (non-cultural), and stratum Y2 are both small and are not associated with archaeological materials (features or artifacts). The disturbed faunal assemblage of course cannot be linked to the components or strata without an extensive radiocarbon dating program.

Terminology

Various terms are used in this analysis, and following calls for clarity and specificity (Casteel and Grayson 1977; Lyman 1994b:51-52), they are defined here. These terms include analytical units, such as MAU, %MAU, and MNI, and observational units, such as fragment, NISP, and element portion. Fragments, specimens, and elements are formed hierarchically (i.e., specimens are derived from fragments, and elements are derived from specimens). *Fragment* refers to each individual piece of faunal material (bone, teeth, horn, hoof, etc.), ideally at the time of recovery in the excavation. For instance, if a mandible fragment with three molars is found intact, but later crumbles into numerous pieces, it is considered to be one fragment. Fragments as used here could therefore include complete elements as well as pieces. In a very few cases, the number of fragments is estimated on the basis of photographs as the bone(s) fragmented during or after recovery. *Specimen* refers to any faunal fragment that can be identified to the level of an element (see below), whereas *element* (or *skeletal element*) refers to a "discrete natural anatomical unit of a skeleton" (Lyman 1994b:39). *NISP* (number of identifiable specimens) is calculated here following Klein and Cruz-Uribe (1984:24-25). NISP are calculated through varying degrees of certainty; these are reflected in the taxon descriptors (e.g., ungulate and cervid) and element descriptors (e.g., metapodial, humerus or femur diaphysis fragment).

Groupings of multiple elements are described in several ways in this chapter. When examining skeletal part frequencies, two types of classification are used: (1) *appendicular* and *axial*, and (2) *long bone elements* and *other skeletal elements*. Appendicular elements include appendicular elements from anterior phalanges to scapula in the forelimb and posterior phalanges to proximal femur in the hind limb. Axial elements include axial elements (defined above) and innominates. Long bones include humeri, radii-ulnae, metacarpals, femora, tibiae, and metatarsals. Other skeletal elements include all other elements. In some analyses, forelimb refers to anterior phalanges through scapula, and hindlimb refers to posterior phalanges through proximal femur.

Another type of grouping is discussed in this chapter, relating to the animal carcass and portions thereof. *Carcass* refers to the entire animal at death, including hide, blood, viscera, antlers, etc. Carcass portions are referred to as *anatomical portions*. These groups include not only skeletal elements and element portions, but associated meat, fat (including bone marrow and bone grease), ligaments, and other products associated with the skeletal elements.

MNE (minimum number of elements) refers to the minimum number of elements per element portion responsible for forming the faunal assemblage under investigation. Various means for estimating MNE based on long bone shafts have been discussed in the literature (Marean and Kim 1998; Marean et al. 2001), however given the relative few identifiable long bone shafts without epiphyses, I have used a fraction summation approach modified from Klein and Cruz-Uribe (1984). Each fragment is examined and assigned (if possible) to element and taxon. Each diagnostic fragment is then given an estimation of the shaft present in intervals of 0%, 10%, 25%, 50%, 75%, 90%, and 100%. Each fragment is sorted by taxon, element (and portion), and side. Finally, an estimation of MNE is calculated for each element on the basis of overlap (estimated through visual comparison of each specimen). Given the fragmented and weathered nature of the assemblage (which resulted in the near absence of cortical bone), no adjustment for size, sex, or age was made. Such matching normally requires complete or near complete element portions, which were extremely rare in this assemblage.

Once MNE has been estimated for each element or element portion from each taxon, calculation of *MNI* (minimum number of individuals) is made, following Klein and Cruz-Uribe (1984). MNI represents the number of individuals necessary to account for the MNE within each species sample, taking into account element and side. Again, no adjustment is made for size, sex, or age for the reasons given above.

MAU (minimal animal units) are defined as anatomical frequency counts (Binford 1984). MAU is designed to estimate skeletal element portion abundance, not taxonomic abundance.

MAU is calculated (per taxon) as MNE/maximum number of element within one skeleton, and does not take into account size, sex, or age (see Binford 1984).

%MAU (standardized or normed MAU) allows for comparisons among samples of different sizes, and is calculated (per taxon and MAU) as: MAU of each element*100/maximum MAU observed in an assemblage (Binford 1984).

%survivorship is calculated by summing all of the present element portions for each bone density scan site (here derived from Kreutzer (1992:276-277), see below) and dividing by the expected numbers of surviving element portions for each scan site given 100% survivorship based on MNI per taxon (see Lyman 1994a:239).

Component 3 Faunal Analysis

Assemblage Description and Composition

A total of 765 faunal provenience units were collected from Component 3 contexts in 1999-2003, with 3 additional provenience units from the 1996 bluff test pit. Component 3 faunal remains consisted of 4,224 fragments and a total weight of 12,068.7 g (12.1 kg). The average weight per provenience unit was 15.7±41.8 g, and ranged from 0.1 g to 523.4 g, and the average weight per fragment was 2.9 g. A total of 176 provenience units were identified to skeletal element or skeletal unit type (23% of total by provenience unit, 71% of total by weight), with 69 of these identified as teeth/enamel fragments or elements containing teeth (mandibles and maxillae), and the remaining 107 provenience units to bone elements. Within these 176 provenience units, numbers of identified specimens (NISP) to element portion and some taxonomic level totaled 192 specimens. Of these 192, 105 (55%) were identified to generic level taxa (12% of total Component 3 faunal provenience units, 58% by weight). Of these, wapiti had a NISP of 73, bison with a NISP of 33, and mammoth with a NISP of 1 (worked ivory rod or point). The remaining 85 specimens were identified as large to very large mammal class and/or Artiodactyla, representing bison, wapiti, or moose, and most likely representing bison or wapiti. No medium sized artiodactyls such as caribou, or other mammalian taxa, such as bear or sheep were found in the Component 3 assemblage. No avian or fish remains of any kind were found within Component 3.

As density is area-dependent, in order to form data useful for intersite comparisons, I calculated assemblage faunal density as the total faunal weight per total area, where total area equals the sum of all 1 m^2 excavation units containing at least one faunal fragment. Assemblage faunal density for Component 3 is 12,068.7g/90.5 m^2, or 133.4 g/m^2. Density per square meter excavation unit ranges from 0.1 to 802.7 g/m^2. A total of 90.5 m^2 contained faunal remains, 80% of the 112.5 m^2 total area excavated below Component 3 (111 m^2 during the 1999-2003 excavation and 1.5 m^2 during the 1996 test pit). Faunal density was reconstructed for the spring 2000 slump area (Blocks N and O). Given (a) the lack of faunal remains in adjacent areas to the west (EU N46E41, N47E41 contained no faunal remains and N47E43 contained only 5.0 g), and (b) the high values in the east (EU N46E44 and N47E44 contained 174.9 g and 191.9 g respectively as well as Feature 3), the 253.1 g found within the slump area (N46E42, N47E42, N46E43, N46E44) are allocated to N46E44, resulting in 432.1 g within that unit. Faunal density for each faunal cluster is discussed below.

All of the large faunal remains were found in a horizontal position, interspersed with lithics and features within the same horizon, ±10 cm. In many cases, lithic items were found adjacent and beneath bone fragments. A total of 1640.3 g of faunal remains were burned (14% of total weight), with observed burn types including calcined (72.2 g, 1%), black charred (180.1 g, 2%), brown charred (491.5 g, 4%), and red charred (906.5 g, 8%). Cylindrical (spiral) fractures, associated with human butchery, were common (26.4% of identified long bone fragments). All of the data point to direct association among the lithics, features, and faunal remains. Post-depositional turbation is considered very limited (see Chapter 4). The occupation surface is largely preserved except possibly near Area C (faunal cluster F6b). Articulations are present (see below), suggesting that post-depositional vertical and horizontal movement was minimal. Various data that support the lack of post-depositional disturbance includes spatial clustering, horizontal orientation of all large bones and lithics, tight vertical distribution of artifacts and fauna, no evidence for colluvial disturbance, little evidence for cryoturbation, no refits between separate layers, large and small lithics have similar distributions, bone weathering is generally similar throughout Component 3, and concentrations of multiple materials in close association (faunal remains, lithics, cobbles, and hearth features).

A list of possible large mammals that could be represented in the Gerstle River Component 3 assemblage is derived from Guthrie (1968), who provides biodiversity data on Late Pleistocene paleontological sites near Fairbanks in central Alaska. Guthrie (1968) suggests a Late

Pleistocene community of 50% bison (*Bison priscus*), 33% horse (*Equus* sp.), 6% mammoth (*Mammuthus primigenius)*, 4% caribou (*Rangifer tarandus*), 3% musk-ox (*Ovibos moschatus*), 2% moose (*Alces alces*), 1% wolf (*Canis dirus*), 1% wapiti (*Cervus elaphus*), and less than 1% of moose-stag (*Cervalces* sp.), sheep (*Ovis dalli*), coyote (*Canis latrans*), lion (*Felis* sp.), saiga antelope (*Saiga tatarica*), camel (*Camelops* sp.), yak (*Bos* sp.), mastodon (*Mastodon americanus*), brown bear (*Ursus arctos*), and saber-toothed cat (*Smilodon* sp.) (percentages based on NISP), unfortunately most of these assemblages are not dated to the latest Pleistocene. This distribution is similar to a community developed from the North Slope based on a large number of radiocarbon dated remains (~30,000 BP): 35% bison, 31% horse, 20% caribou, 8% mammoth, and 5% musk-ox (Matheus 2003). Wapiti are noticeably absent or represented by low frequencies on both of these lists, though Guthrie (1983a:249) notes that wapiti may have increased in the terminal Pleistocene and early Holocene. A number of the listed taxa were not present at the time of occupations at Gerstle River, including camel (terminal date of ~27900 BP in Alaska), moose-stag (~21300 BP), saiga (~12200 BP), horse (~11900 BP), mammoth (~11400 BP), and other Pleistocene fauna like mastodon, lion, and saber-toothed cat.

The cervid remains found at Gerstle River were compared with wapiti, moose, and caribou specimens available at the Department of Anthropology at UAF and the University of Alaska Museum. The cervid specimens are considered to be wapiti given their size and morphology, though it is possible that large wapiti and smaller moose overlap in size, especially as Late Pleistocene wapiti recovered at Broken Mammoth and Dry Creek are larger than modern wapiti (Guthrie 1983a:250; Yesner and Crossen 1992:224). However, the element sizes, proportions, and morphology all suggest wapiti is the only taxa represented by the cervid remains within Component 3. The bovid remains are larger than musk-ox, and in many cases were larger than the plains bison (*Bison bison bison*) comparative elements. Two bison specimens from Gerstle River (from disturbed contexts) were dated to about 9400 BP, and based on mtDNA analysis were interpreted to be *Bison priscus*, or steppe bison (Shapiro et al. 2004).

Bone preservation is considered very poor. The bone is friable and brittle, and generally fragmented when removed from the sediment. Great care was taken to document each bone while it was *in situ,* such as drawing detailed plan views, before removal. Once allowed to dry, the bone fragments were generally still very fragile, and in some cases rootlets that had invaded all parts of the bone tissue essentially held together the fragments. When recovered in the field, many larger bones had homogeneous light gray stains surrounding the bone in all directions for a distance of about 2 cm. Many of the bones were burned (white/calcined, black charred, reddened, and brown charred), and those that were not were stained to a pale yellowish brown (10 YR 6/2) or a pale brown (5YR 5/2). The bones did not exhibit differences in staining or weathering relative to the surface that contacted the ground.

Weathering patterns in Component 3 fauna are consistent throughout the collection, with little difference relating to spatial position within the component, and consist of extensive root/acid etching leading to surface deterioration, rootlet penetration, mosaic cracking, surface flaking, and some longitudinal cracking of some of the larger long bone fragments. Due to this weathering, most of the cortical surfaces are deeply deteriorated or absent. Therefore, measurements described below should be seen as minima. Also, features present on the bones, such as cut marks, carnivore and rodent gnawing, are difficult to discern. However, extensive gnawing, pitting, or scoring was not observed on the Component 3 fauna, though one specimen did have small circular holes, about 2.5 mm in diameter (UA2000-54-8). Carnivore gnawing, based on morphological characteristics defined by Binford (1981) such as crenelated, scalloped, or jagged lateral edges of long bone fragments, gnawed epiphyses, channelling etc., were not observed in the Gerstle River Component 3 fauna, and subsequently, carnivore modification is not suspected to be a major factor in the formation of this assemblage (see below). Rodent gnawing was also not observed on the Gerstle River Component 3 fauna.

Table 6.2 summarizes numbers of fragments, weight, NISP, and MNE for the Component 3 faunal assemblage by taxon. MNE and MNI calculation are discussed below. With the exception of a single mammoth ivory worked point or rod, all of the other faunal specimens could be either bison or wapiti. Those specimens that could not be differentiated between bison and wapiti were considered artiodactyls, with size classes large to very large. In other words, the specimens marked as Artiodactyla are almost certainly bison or wapiti. Wapiti is seen to be dominant in terms of NISP, with over twice as many as bison (73 vs. 33). However, with a large number of large artiodactyl non-enamel specimens (NISP=32) and the calculation of MNI for both taxa (see below), these numbers may reflect that bison remains have undergone more extensive destruction, through butchery or subsequent taphonomic processes.

Table 6.3 summarizes Component 3 faunal remains by skeletal unit type (NISP and weight). All of the indeterminate specimens were vertebra fragments (axial), and are probably also bison or wapiti, but due to their highly fragmented nature, could not be distinguished from other large mammals such as moose or various bears. For analytical purposes, these specimens are lumped with the artiodactyl taxonomic category given the assemblage taxonomic composition and general size and morphology. All of the mandible/maxilla fragments with teeth were identified as wapiti (see below). The enamel specimens unassigned to taxa are probably also wapiti given this patterning.

Lower limb specimens were the most commonly identified in the assemblage for both wapiti and bison (almost half of the total weight per taxon). However, a number of fragments were identified as upper limb elements, but could not be assigned to a specific element portion of taxon with assurance, and therefore are not counted within the NISP (see below). Given the relatively high percentage of identified remains (71% by weight), it is suggested that most of the bones present within the excavated area were in fact identified, and form a suitable data set for further analysis.

A number of long bone shaft fragments were tentatively identified as upper limb bones (NISP=13 based on 21 fragments) and lower limb bones (NISP=3 based on 3 fragments) based on shaft curvature, length, thickness, and morphology. Total weight of these specimens was 860.1 g (25% of total unidentified fauna weight, 7% of total fauna weight). The three lower limb bone specimens are tentatively identified as metapodial shaft fragments with a total weight of 50.6 g. The upper limb bone specimens are tentatively identified as femur, humerus, radius, or tibia (n=5), femur or humerus (n=2), femur (n=2), humerus or tibia (n=1), tibia or femur (n=1), tibia or metatarsal (n=1), and ulna (n=1) shaft fragments with a total weight of 773.0 g. Since these specimens could not be positively identified as a specific element portion, they are not included in the NISP, MNE, MNI, MAU, and %MAU calculations and further analyses below.

Table 6.2. Summary of Component 3 diagnostic skeletal elements by taxon.

Taxon	*N fragments*	*Weight (g)*	*NISP*	*MNE*
Cervus elaphus	355	4861.5	73	67
Bison priscus	104	2232.8	33	31
Artiodactyla (L or VL)	275	1461.3	85	36
Mammuthus sp.	1	8.6	1	1
TOTAL	735	8564.2	192	135

Table 6.3 Summary of Component 3 skeletal unit types by taxon (NISP, weight).

Taxon	*Axial*		*Maxilla, Mandible, Teeth*		*Upper Limb*		*Lower Limb*	
	NISP	*Wt.*	*NISP*	*Wt.*	*NISP*	*Wt.*	*NISP*	*Wt.*
Cervus elaphus	10	715.2	18	848.8	13	1251.8	30[2]	2045.7
Bison priscus	8	628.8	-	-	4	603.2	20	1000.8
Artiodactyla (L or VL)	13	605.4	52	27.8	10	720.9	6	107.2
Mammuthus sp.	-	-	1	8.6	-	-	-	-
TOTAL	31	1949.4	71	885.2	27	2575.9	56	3153.7

MNE and MNI Calculation

MNE counts for each taxon were developed following the protocols described above. For the purposes of this study, the very few unknown medium to very large mammal specimens (NISP=7) are lumped with the unknown artiodactyl specimens, thus resulting in three taxa categories: bison, wapiti, and unknown artiodactyls. Table 6.4 lists NISP, MNE, and derivative MAU and %MAU values for these three taxa in Component 3. Table 6.5 lists these data for combined data for all artiodactyls, providing the most conservative view of the artiodactyls preserved at Gerstle River Component 3. Figure 6.3 illustrates the %MAU values for each taxon. Figure 6.4 illustrates the %MAU for wapiti and bison. The skeletal images are scaled to the midpoints of the body length ranges provided in Nowak (1991). Figure 6.5 illustrates combined artiodactyl %MAU on a wapiti skeleton.

Recovered tarsals, carpals, and phalanges are complete or nearly complete allowing for straightforward MNE calculation. Axial and upper limb bones were generally fragmented, and MNEs were calculated on the basis of element portion and diaphysis percentage as described above for long bones, and the portions present for irregular bones. Marean and Frey (1997) note that long bone abundance estimates based only on epiphyses will likely underestimate the actual value since epiphyses are less dense than shafts and are more susceptible to density-dependent attritional processes. It is important to note that MNE and MNI calculations detailed below are based on *both* long bone epiphyses and shaft fragments with diagnostic landmarks; however, it is possible that MNE based on these shafts will underestimate MNE relative to epiphyses, given that epiphyses are more readily identifiable to element portion and taxon.

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[2] Note, wapiti lower limb NISP presented in this table is 30, whereas Tables 7.4 and 7.5 calculations yield 31. This is because one complete L metatarsal was subdivided into proximal and distal portions for MNE calculation.

The most common elements besides maxillae are metacarpals and metatarsals (bison MNE=8, wapiti MNE=11, total artiodactyl MNE=19). Given the reliance on metapodials, other long bones, and maxilla-mandible fragments to calculate MNE and MNI, these specimens were checked for refits. Eleven specimens refit into five element portions:

UA2003-54-305 and UA2003-54-1157 refit (R metacarpal (D75, D90)

UA2003-54-1055 and 1056 refit (R metatarsal (P10, P50)

UA2001-71-336 and 337 refit (L metatarsal, D25, D25)

UA2000-54-245 and 246 refit (L metacarpal, D10, P75)

UA2000-54-289 and UA2003-54-1055 and 1056 refit (R metatarsal, complete)

In addition to these five element portions, UA2001-71-537 (R tibial crest) and UA2001-71-538 (tibia shaft fragment) do not refit, but likely belong to the same element given their location adjacent to one another, and are considered as such for the purposes of this analysis. UA99-62-861 (R distal condyle of metapodial) does not refit with UA2001-71-1297 (bison R metacarpal, D25). UA99-62-611 consists of three large artiodactyl metapodial distal fragments (including both condyles) found in direct association, and given its size, cortical bone thickness, flatness of the (presumed) plantar region of the diaphysis, and given its position very close to UA99-62-206 (bison R metacarpal), that is very similar in color and texture, this specimen is considered a bison L metacarpal. UA99-62-861 is a large artiodactyl right condyle, and given its very large size and close proximity to UA99-62-819 (bison L metatarsal), UA99-62-861 is considered to be part of this element. In both cases, this tentative assignment does not change MNI calculations.

A number of artiodactyl tooth rows and surrounding mandibular and maxillary bone were recovered within Component 3 (see Table 6.14). Given provenience and morphology, a number of paired mandibles and maxilla were reconstructed. UA2001-71-646 and 647, R and L maxilla respectively, and UA2000-54-774 and 775, R and L mandible fragments respectively, are likely pairs. UA2003-54-56, 80, and 90 were portions of the same (L) mandible, which included P2, P3, P4, M1, and M2. Other tooth rows include UA99-62-311 and 312 (L maxilla), UA99-62-455 (L maxilla), UA99-62-614 (R mandible), UA2000-54-0012 (L maxilla), and UA2001-62-227 (R maxilla). All of these tooth rows are considered to be wapiti, given their size and morphology, especially crown height, which is lower in wapiti compared with bison (see analysis below).

Maxillae and metapodials were used to estimate MNI for both bison and wapiti because the former had the highest MNE values for wapiti, and the latter were less fragmented than the upper limb bones, and therefore more easily identifiable to generic taxon, and they had the highest MNE values for bison and the second highest for wapiti (after maxilla). Figures 6.1 and

6.2 illustrate the metapodials from Gerstle River Component 3 faunal assemblage. The highest MNI values for bison were three R distal metacarpals, and two L proximal metatarsals. The highest MNI values for wapiti were three L proximal metatarsals, three R distal metacarpals, and two R distal metatarsals. As the only metapodial identified to unknown artiodactyl consisted of a right condyle, which could not be refitted to any known specimen, this yields a conservative MNI estimate of three wapiti and three bison associated with Gerstle River Component 3. Maxilla abundance yields an MNI estimate of five wapiti, two additional individuals than MNI estimated by metapodials alone (see below).

Given the differences in skeletal unit types for bison and wapiti vs. unknown artiodactyls (see Tables 6.3, 6.4, and 6.5 and Figures 6.3 and 6.33), the minimum number of animals represented at Gerstle River Component 3 includes three bison and five wapiti. The unidentified artiodactyl element portions are generally different from those identified to species, with relatively high numbers of isolated teeth and enamel fragments, rib, scapula, and tibia fragments. When all artiodactyl specimens are analyzed (Table 6.5), none of the MNE values indicate more than eight total large artiodactyls present within the component.

Figure 6.4 plots %MAU values for wapiti and bison in order to assess similarities in relative abundance. The %MAU values are significantly correlated (r_s=0.312, p=0.044), indicating that element portion abundance are similar and suggesting that bison and wapiti carcasses and anatomical portions underwent similar processes within the site. The correlation coefficient would be higher if some of the unknown artiodactyl specimens (such as scapulae and femora) were in fact wapiti. Wapiti are represented by relatively more cranial and mandible portions, radii, ulnae, and distal tibiae. Bison are represented by relatively more distal metacarpals, scapulae, and proximal femora. Given this correlation between taxa, and in order to more fully explore the Component 3 faunal analysis, three sub-assemblages are considered in the following analyses: (1) wapiti, (2) bison, (3) combined bison, wapiti, and unidentified large artiodactyls. Specific differences relating to taxa are examined for each analysis.

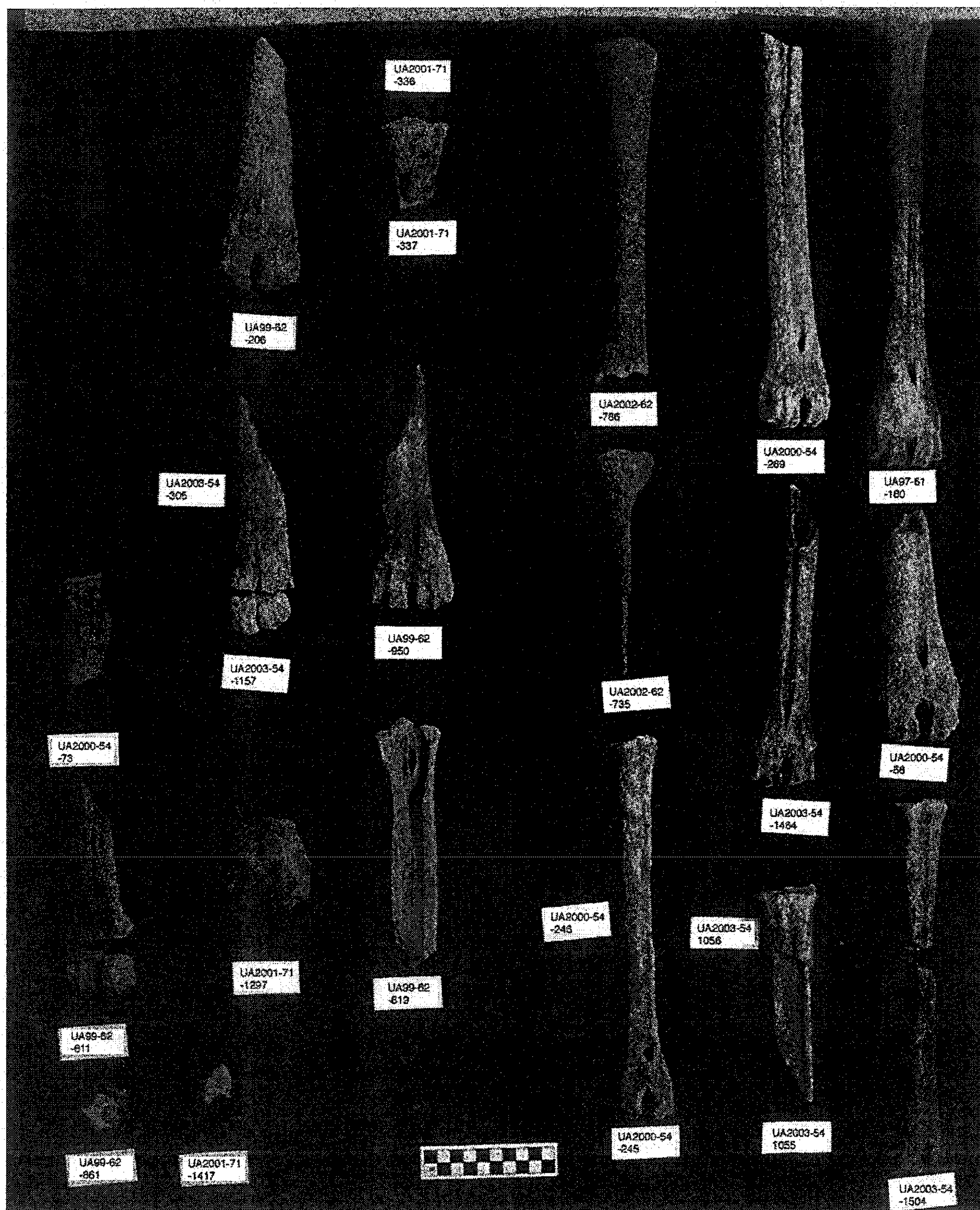


Figure 6.1 Component 3 metapodials, dorsal view (note UA2003-54-1055 and 1056 refit with UA2000-54-289). Note that UA200-54-245 and 246 are split longitudinally and do not represent the full width of the diaphysis or proximal epiphysis.

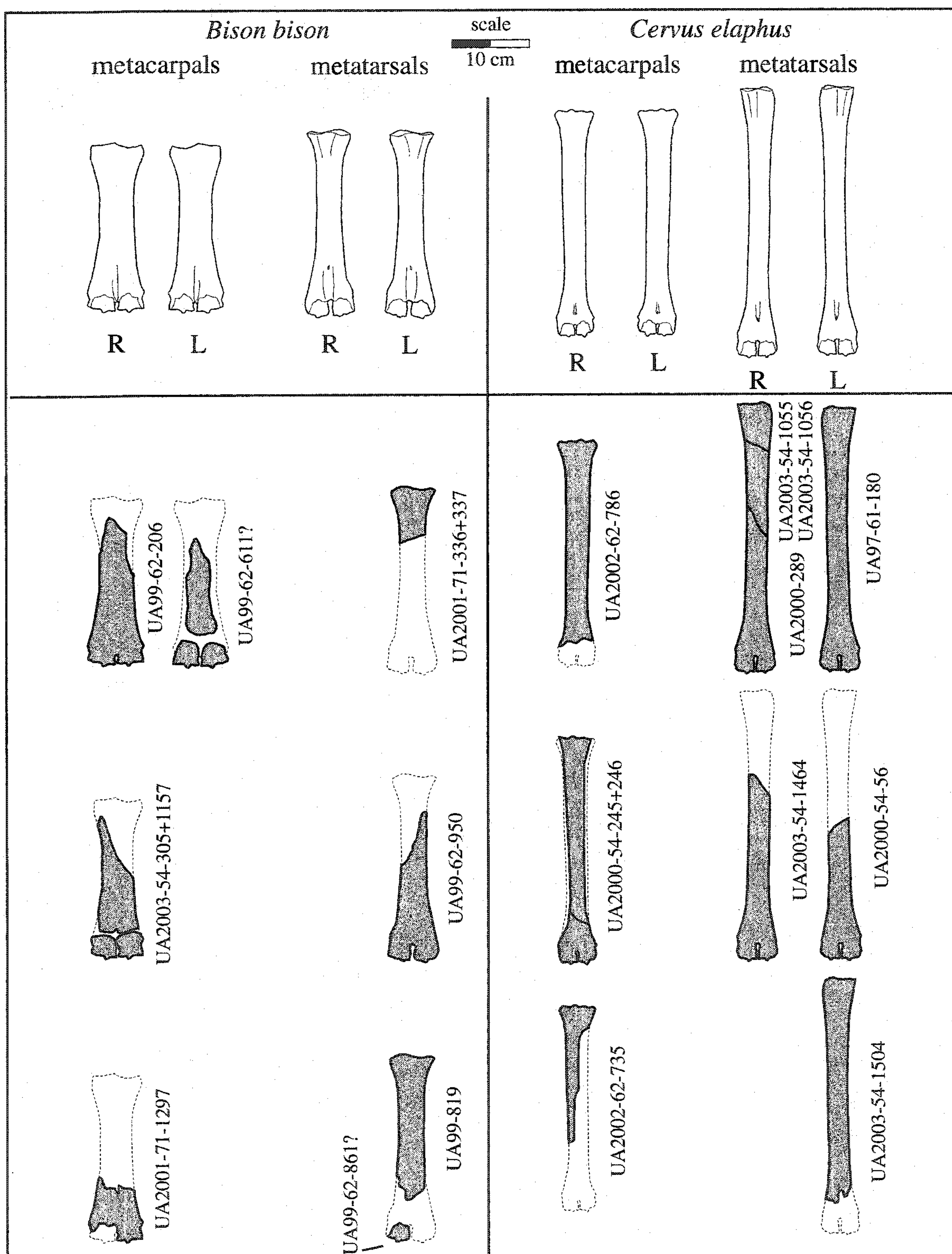


Figure 6.2 Component 3 metapodial schematics for MNE and MNI calculation, dorsal view (shaded areas indicate portion preserved per specimen).

Table 6.4 NISP, MNE, MAU, and %MAU values per taxon for Component 3 artiodactyls.

Skeletal Element portion	*Cervus elaphus*				*Bison priscus*				*Unknown Artiodactyla*			
	NISP	*MNE*	*MAU*	*%MAU*	*NISP*	*MNE*	*MAU*	*%MAU*	*NISP*	*MNE*	*MAU*	*%MAU*
Cranium	1	1	1.00	28.57	-	-	-	-	-	-	-	-
Maxilla	9	7	3.50	100.00	-	-	-	-	-	-	-	-
Mandible	7	5	2.50	71.43	-	-	-	-	-	-	-	-
Teeth (isolated)	2	2	NA	NA	-	-	-	-	10	13	NA	NA
Enamel fragments	-	-	-	-	-	-	-	-	43	NA	NA	NA
Hyoid	-	-	-	-	-	-	-	-	-	-	-	-
Atlas Vertebra	-	-	-	-	-	-	-	-	1	1	1.00	66.67
Axis vertebra	-	-	-	-	-	-	-	-	-	-	-	-
Cervical 3-7	-	-	-	-	-	-	-	-	1	1	0.20	13.33
Thoracic 1-14	-	-	-	-	-	-	-	-	-	-	-	-
Lumbar 1-5/6	5	5	1.00	28.57	6	6	1.00	50.00	5[3]	5	1.00	66.67
Vertebra, unknown	-	-	-	-	-	-	-	-	5	3	NA	NA
Sacrum	1	1	1.00	28.57	1	1	1.00	50.00	-	-	-	-
Caudal vertebra	-	-	-	-	-	-	-	-	-	-	-	-
Sternebra	-	-	-	-	-	-	-	-	-	-	-	-
Costal cartilage	-	-	-	-	-	-	-	-	-	-	-	-
Rib	-	-	-	-	-	-	-	-	3	2	0.07	4.76
Scapula	-	-	-	-	2	2	1.00	50.00	2	2	1.00	66.67
Humerus, prox.	-	-	-	-	-	-	-	-	-	-	-	-
Humerus, deltoid tuberosity	-	-	-	-	-	-	-	-	1	1	0.50	33.33
Humerus, dist.	2	2	1.00	28.57	1	1	0.50	25.00	-	-	-	-
Radius, prox.	4	4	2.00	57.14	-	-	-	-	-	-	-	-
Radius, dist.	2	2	1.00	28.57	-	-	-	-	-	-	-	-
Ulna	2	2	1.00	28.57	-	-	-	-	-	-	-	-
Carpals	8	8	0.67	19.14	2	2	0.17	8.50	2	2	0.17	11.11
Metacarpal, prox.	3	3	1.50	42.86	-	-	-	-	-	-	-	-
Metacarpal, dist.	1	1	0.50	14.29	5	4	2.00	100.00	-	-	-	-
5th metacarpal	-	-	-	-	-	-	-	-	-	-	-	-
Innominate	3	2	1.00	28.57	1	1	0.50	25.00	2	1	0.50	33.33
Femur, prox.	-	-	-	-	1[4]	1	0.50	25.00	-	-	-	-
Femur, dist.	1[5]	1	0.50	14.29	-	-	-	-	2[6]	1	0.50	33.33
Tibia, prox.	-	-	-	-	-	-	-	-	-	-	-	-
Tibia, tibial crest	1	1	0.50	14.29	-	-	-	-	4	3	1.50	100.00

[3] Includes UA99-62-0288, an articulated column that fragmented into numerous small pieces upon recovery (total MNE is estimated at 5 vertebra, with three positively identified as lumbar vertebra). For the purposes of this analysis, this provenience unit is considered to represent 5 lumbar vertebra.
[4] Femur head.
[5] Medial condyle fragment
[6] Supracondyloid fossa and surrounding diaphysis including part of lateral supracondyloid crest, and lateral condyle fragment.

Table 6.4 Continued.

Tibia, dist.	2	2	1.00	28.57	-	-	-	-	(1)[7]	(1)	0.50	33.33
Patella	-	-	-	-	-	-	-	-	-	-	-	-
Astragalus	1	1	0.50	14.29	1	1	0.50	25.00	-	-	-	-
Calcaneus	2	2	1.00	28.57	2	2	1.00	50.00	-	-	-	-
Other Tarsals	3	3	0.75	21.43	-	-	-	-	1	1	0.25	16.67
Metatarsal, prox.	4	3	1.50	42.86	3	2	1.00	50.00	-	-	-	-
Metatarsal, dist.	4	4[8]	2.00	57.14	2	2	1.00	50.00	-	-	-	-
Metapodial, unknown	-	-	-	-	-	-	-	-	1	1	NA	NA
1st phalanx	3	3	0.38	10.86	2	2	0.25	12.50	1	1	0.13	8.33
2nd phalanx	1	1	0.13	3.71	2	2	0.25	12.50	-	-	-	-
3rd phalanx	1	1	0.13	3.71	2	2	0.25	12.50	-	-	-	-
Proximal sesamoid	-	-	-	-	-	-	-	-	-	-	-	-
Distal sesamoid	-	-	-	-	-	-	-	-	-	-	-	-

Table 6.5 NISP, MNE, MAU, and %MAU values for combined artiodactyls (wapiti, bison, and unidentified artiodactyls).

Skeletal Element portion	*Combined Artiodactyla*			
	NISP	*MNE*	*MAU*	*%MAU*
Cranium	1	1	1.00	28.57
Maxilla	9	7	3.50	100.00
Mandible	7	5	2.50	71.43
Teeth (isolated)	12	12	NA	NA
Enamel fragments	43	NA	NA	NA
Hyoid	-	-	-	-
Atlas Vertebra	1	1	1.00	28.57
Axis vertebra	-	-	-	-
Cervical 3-7	1	1	0.20	5.71
Thoracic 1-14	-	-	-	-
Lumbar 1-5/6	16	16	3.00	85.71
Vertebra, unknown	5	3	NA	NA
Sacrum	2	2	2.00	57.14
Caudal vertebra	-	-	-	-
Sternebra	-	-	-	-
Costal cartilage	-	-	-	-
Rib	3	2	0.07	2.04
Scapula	4	4	2.00	57.14
Humerus, prox.	-	-	-	-
Humerus, deltoid tuberosity	1	1	0.50	14.29
Humerus, dist.	3	3	1.50	42.86
Radius, prox.	4	4	2.00	57.14

[7] Distal tibia fragment consists of L tibia (distal-posterior portion with no articular surface) for a total MNE of 1.
[8] UA97-180 is a complete L metatarsal, with a MNE count of 2, proximal and distal metatarsal.

Table 6.5 Continued.

Radius, dist.	2	2	1.00	28.57
Ulna	2	2	1.00	28.57
Carpals	12	12	1.00	28.57
Metacarpal, prox.	3	3	1.50	42.86
Metacarpal, dist.	6	5	2.50	71.43
5th metacarpal	-	-	-	-
Innominate	6	4	2.00	57.14
Femur, prox.	1	1	0.50	14.29
Femur, dist.	3	2	1.00	28.57
Tibia, prox.	-	-	-	-
Tibia, tibial crest	4	4	2.00	57.14
Tibia, dist.	3	3	1.50	42.86
Patella	-	-	-	-
Astragalus	2	2	1.00	28.57
Calcaneus	4	4	2.00	57.14
Other Tarsals	4	4	1.00	28.57
Metatarsal, prox.	6	5	2.50	71.43
Metatarsal, dist.	6	6	3.00	85.71
Metapodial, unknown	1	1	NA	NA
1st phalanx	6	6	0.75	21.43
2nd phalanx	3	3	0.38	10.71
3rd phalanx	3	3	0.38	10.71
Proximal sesamoid	-	-	-	-
Distal sesamoid	-	-	-	-

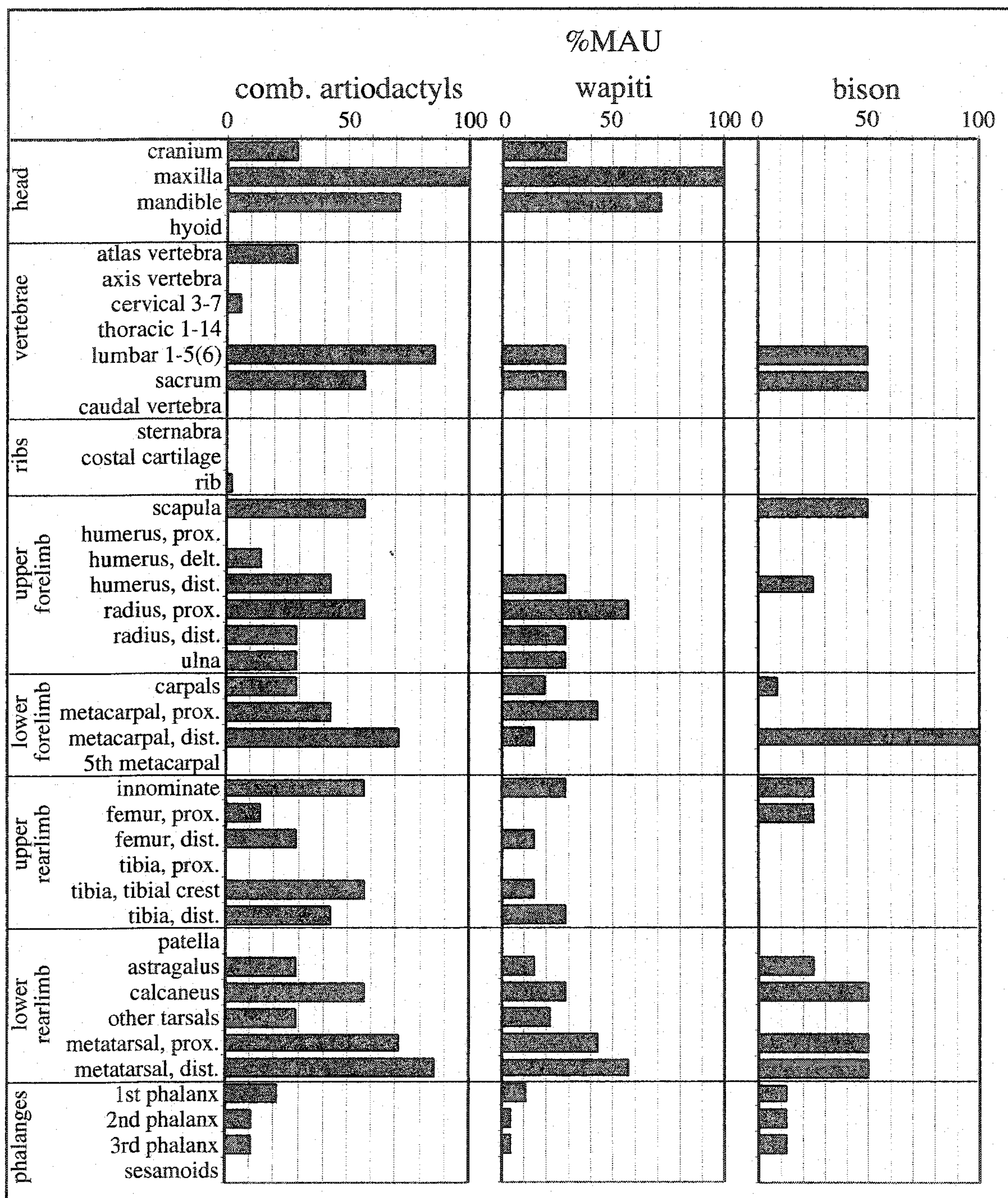


Figure 6.3 %MAU values for combined artiodactyls, wapiti, and bison.

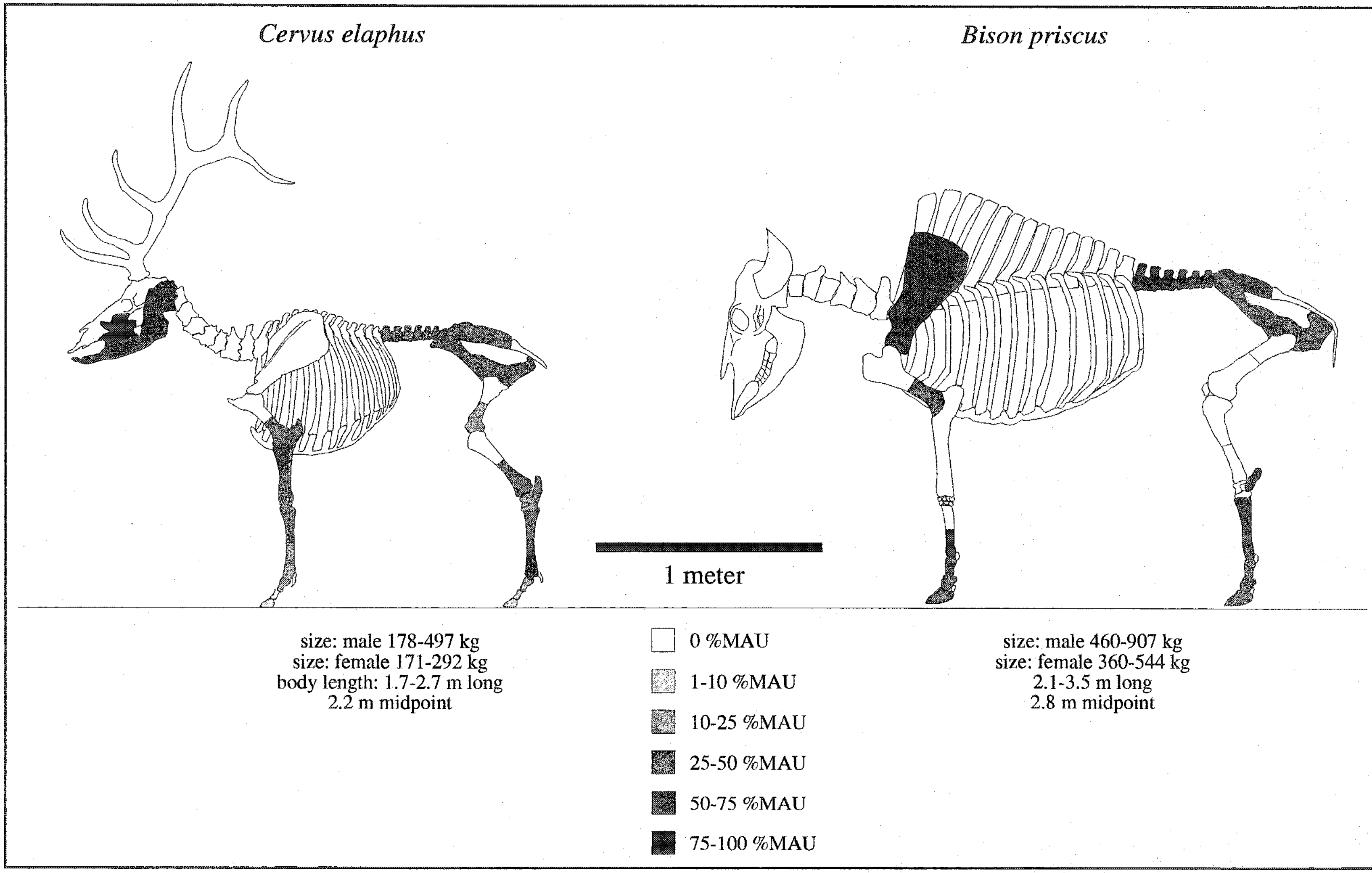


Figure 6.4 Wapiti and bison skeletal comparison and %MAU values at Gerstle River Component 3 (sizes based on midpoints of body length ranges from Nowak 1991 for *Cervus elaphus* and *Bison bison*; masses from Wilson and Reeder 1993)

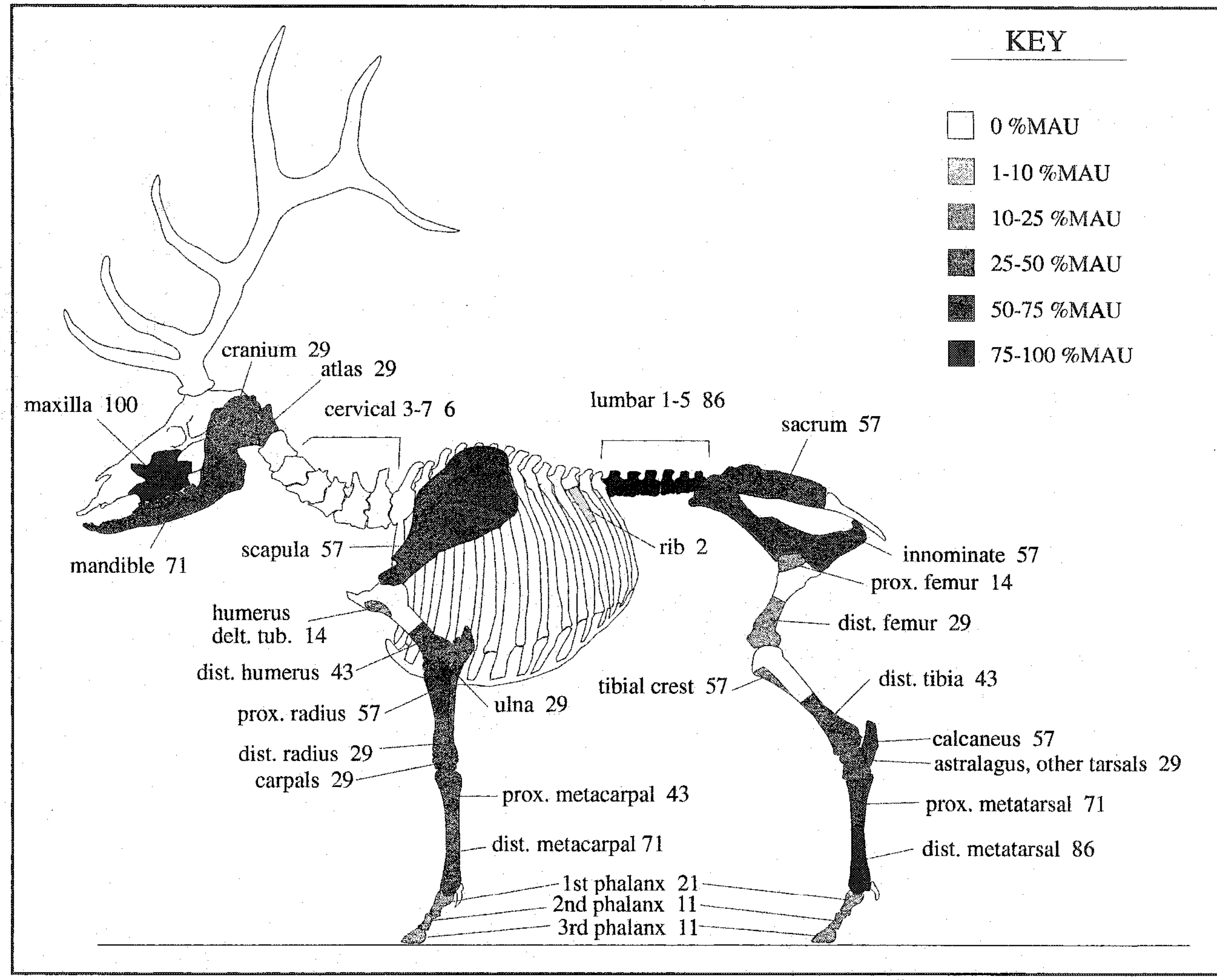


Figure 6.5 Combined artiodactyl %MAU values illustrated on wapiti skeleton (note rib and cervical portions are arbitrary).

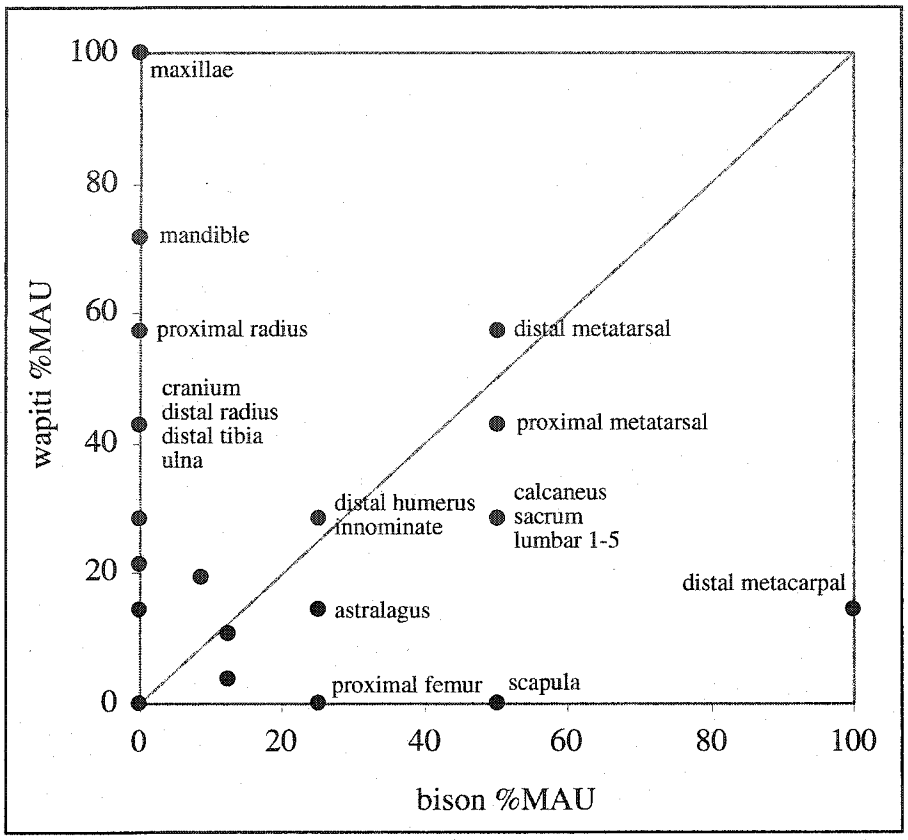


Figure 6.6 Comparison of bison and wapiti %MAU.

Spatial Analysis

Spatial analysis on Component 3 faunal materials is embedded within each analytical section (e.g., weathering, fragmentation, age and sex estimation) and below. Analysis of each spatial concentration of fauna is detailed below, and is expanded within specific analytical sections that follow. Spatial aggregation for Component 3 is based on two hierarchical spatial groupings, *provenience unit* and *faunal cluster*. Provenience unit has already been defined as the material associated with a specific three dimensional location. Faunal clusters are defined here as faunal concentrations separated by areas devoid of faunal remains, and are based on 20 g/0.25m^2 isopleths, distance between large bone fragments, and occupation layer topography. The clusters are labeled as *faunal clusters F1* through *F9*. Given differences in bone modification and co-presence of lithic concentrations and features, cluster F6 was further subdivided into F6a and F6b (see below).

Two types of spatial analyses are conducted on the faunal remains. The first uses spatial clustering of fauna to demarcate faunal clusters (see above), which are then analyzed using hierarchical clustering and boxplots for heuristic purposes to assess differences among clusters. Hierarchical clustering was performed on all faunal clusters (except F8, see below) using Ward's method and squared Euclidean distance measures, with values transformed to z-scores. Clustering results are presented in Figures 6.7-6.8. The second analysis is based on overall spatial 3-point distributions across the site both within the context of the faunal clusters and of the entire component. These distributions are illustrated in Figures 6.9-6.21. Figures 6.22-6.27 show clustered faunal remains *in situ*.

The faunal remains within Component 3 exhibit clear spatial patterning (Figures 6.9-6.14). There are two open areas devoid of fauna, west of Feature 1, between Features 8 and 11. Nine clusters were visually identified based on the criteria listed above (see Table 6.6 and Figure 6.9-6.15). Clusters F1, F3, F4, and F9 are directly associated with hearth areas and lithic concentrations. Clusters F2, F5, F7, F8, and to a lesser extent F6, are located in areas with little or no lithic concentrations and no cultural features. Cluster F1 is associated with Area A[9] and Feature 10 (Figures 6.10 and 8.20). Cluster F3 is associated with Subarea B1 and Feature 1 (Figures 6.11 and 8.14). Cluster F4 is associated with Subarea B2 and Features 3 and 5 (Figures 6.12, 6.22, and 1.20). Cluster F9 is associated with Area D and Features 13, 14, and 16 (Figure 6.13 and 6.27). Cluster F6 is located partially within an area devoid of lithics and features, east of Feature 9 (Figures 6.13 and 2.5), however a portion extends into Feature 12 and Feature 18 to the north (Figure 8.23). The analytical areas for each cluster vary from 1.3 m^2 (cluster F8) and 18.0 m^2 (cluster F6), with an average of 10.2±4.9 m^2. When cluster F8 is excluded and clusters F6a and F6b are demarcated, the average is 10.1±2.7 m^2, indicating relatively similar spatial distributions.

While most of the clustering generates relatively clear boundaries, there exists some potential boundary ambiguity. The boundaries between Clusters F4 and F5, Clusters F4 and F7, and Clusters F3 and F5 are somewhat difficult to distinguish on the basis of 3-pointed data, and are demarcated as shown in Figure 6.15 based on density isopleths. Cluster F6 may be an amalgam of two clusters, with a reasonable division shown as a heavy dashed line in Figure 6.15.

[9] Areas A-D are based on discrete lithic concentrations and are developed in Chapter 10. Area A is associated with Blocks F and V, Area B with Blocks A, B, K, L, N, O, P. Q, and R, Area C with Blocks T, U, and X, and Area D with Blocks Y, Z, and AA.

Table 6.6 Component 3 faunal cluster data summary.

Faunal Cluster	*Associated with features and lithics*					*Not associated with features and lithics*			
	F1	*F3*	*F4*	*F9*	*F6b*	*F2*	*F7*	*F5*	*F6a*
Area (m^2)	8.0	8.0	10.0	11.3	8.0	16.0	7.5	12.0	10.0
N fragments	487	417	672	936	489	28	268	500	412
Total wt (g)	2200.8	640.2	1297.9	1763.6	550.1	373.4	900.2	2847.0	1204.0
Avg. wt. (g)	4.5	1.5	1.9	1.9	1.1	13.3	3.4	5.7	2.9
Wt. Density (g/m^2)	275.1	80.0	129.8	156.1	68.8	23.3	120.0	237.3	120.4
Shaft wt. (% of all long bones)	33	26	27	34	82	63	58	23	82
Bone type	+long	+long	+long	+long	+long	-long	+long	-long	-long
%Unid. wt.	7	12	14	8	15	6	13	3	9
%Long wt.	58	54	71	62	72	43	64	42	50
%Flat wt.	19	2	1	14	3	13	16	17	18
%Teeth wt.	11	27	5	0	0	15	5	3	20
%Irreg. wt.	5	4	10	16	10	23	2	35	3
%Burn wt.	3	41	4	11	5	0	0	4	0
%NISP wt.	67	81	67	73	56	55	55	91	44
NISP wapiti/bison	50	60	90	100	57	67	17	72	63
MNI bison	1	1	1	0	1	1	2	1	1
MNI wapiti	1	1	1	2	1	1	1	2	1
Skeletal Unit Type	Long bones	Axial, teeth	Long bones	Long bones	Long bones	Axial, teeth	Long bones	Mixed	Axial, teeth
%Axial wt.	21	45	0	3	6	43	2	40	35
%Teeth wt.	15	22	7	0	0	28	9	3	40
%U. limb wt.	19	0	21	27	60	29	43	49	10
%L. limb wt.	45	33	71	71	34	0	46	8	14
Skeletal Unit Type 2	Append	Axial	Append	Append	Append	Axial	Append	Mixed	Axial
%Axial wt.	36	67	8	3	6	71	11	43	75
%Append. wt.	64	33	92	97	94	29	89	57	25
Articulated %NISP wt.	15	41	12	14	0	0	0	40	17
Fragmentation	Low	High	High	High	High	Low	Low	Low	High
Interpretation	Processing areas, marrow extraction					Disposal areas		Staging	?

Note: for variables from Area to %Burn wt., data include all faunal fragments except for 13 not identifiable to cluster (n=4209 fragments), for variables from %NISP wt. to Skeletal Unit Type, data include all NISP (n=192). Fragmentation summary is based on average weight per fragment for each cluster (above or below the mean for all groups).

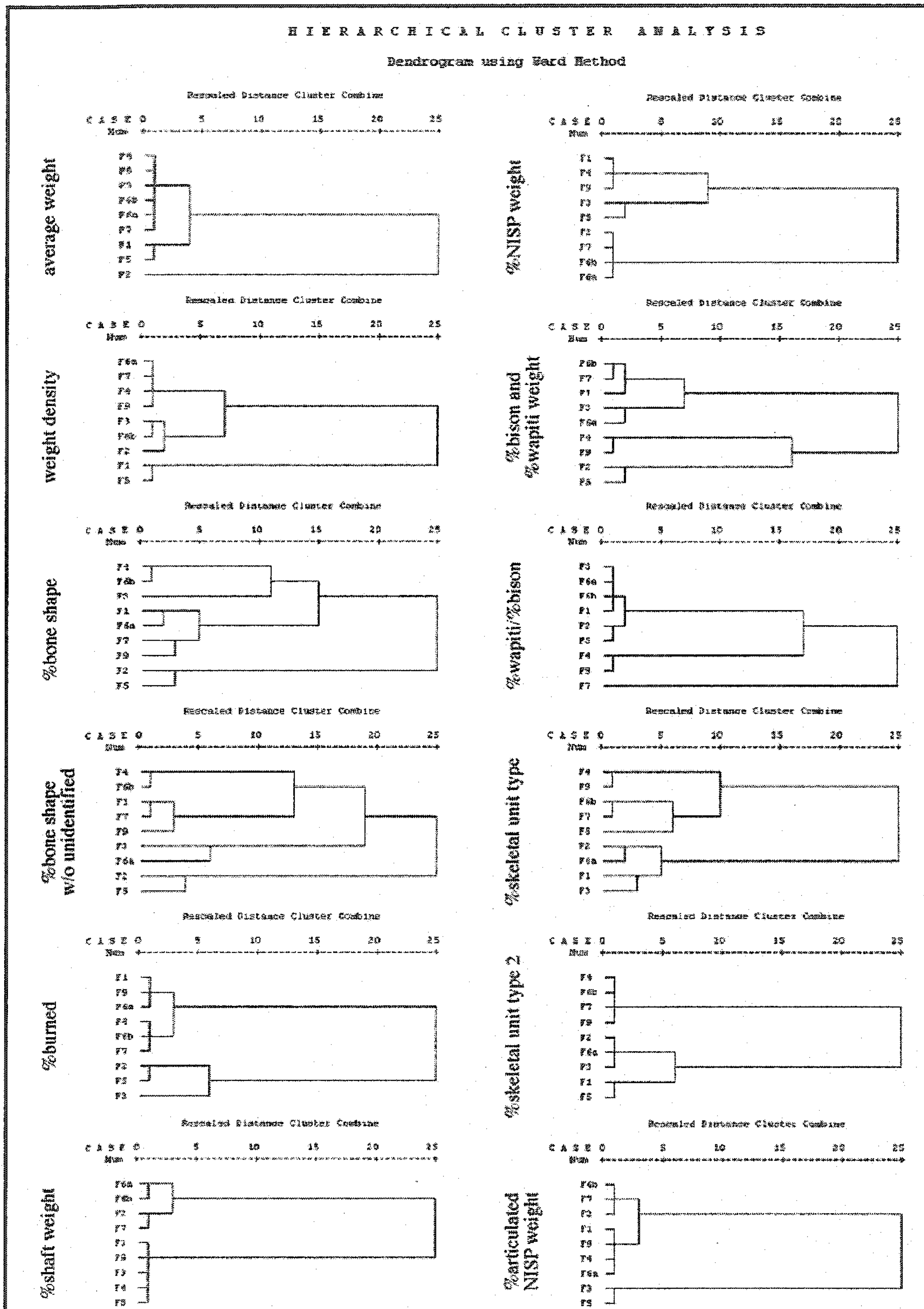


Figure 6.7 Hierarchical cluster results for faunal clusters (see Table 6.6).

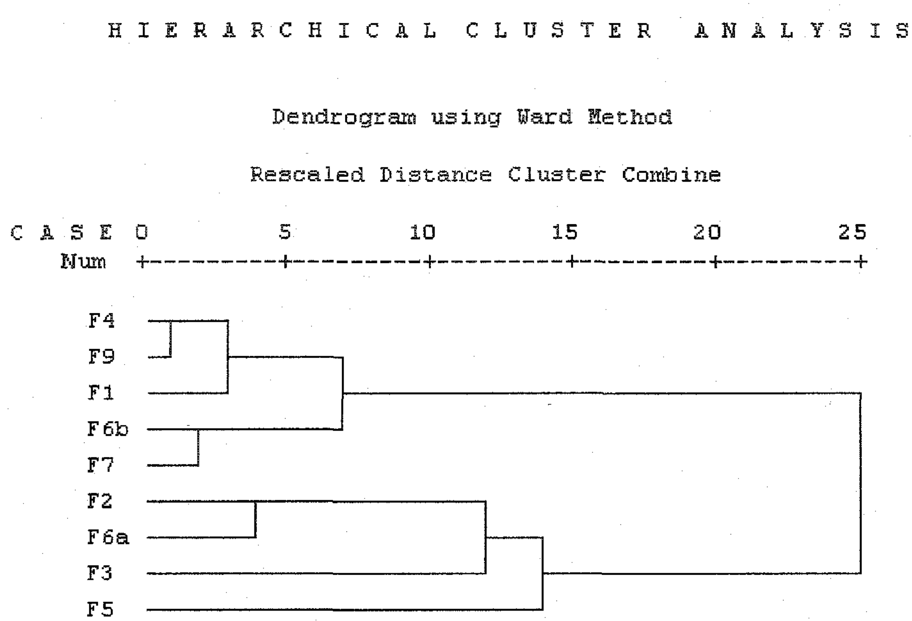


Figure 6.8 Hierarchical cluster results for combined variables (co-occurrence with lithic concentrations, average weight, weight density, %shaft weight, %bone shape, %burned, %skeletal unit type, %articulated NISP weight).

For the following analysis, F6 will be clustered as one group, and then as two clusters, with F6a representing the group east of Feature 9, and F6b representing the group overlapping with lithics and features in Area C.

Interpreting the functional relationships among these faunal clusters and the features/lithics requires evaluation of various datasets. Table 6.6 lists summary faunal data within each faunal cluster, ordered by co-presence or absence of lithics and features. Cluster F8 is excluded given the small excavated area and relatively limited interpretive value. Details of this summary table are discussed below.

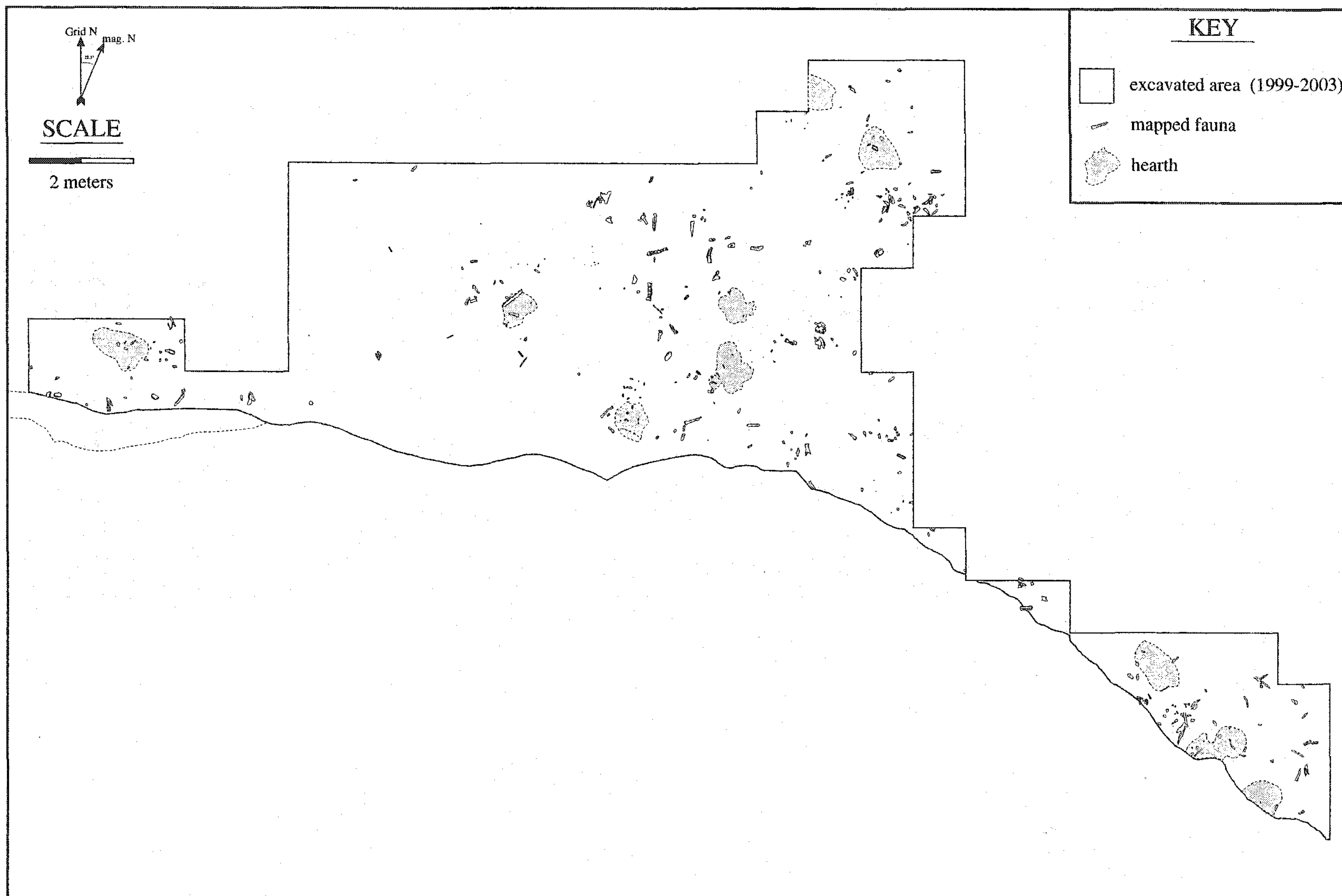


Figure 6.9 Horizontal distribution of faunal remains.

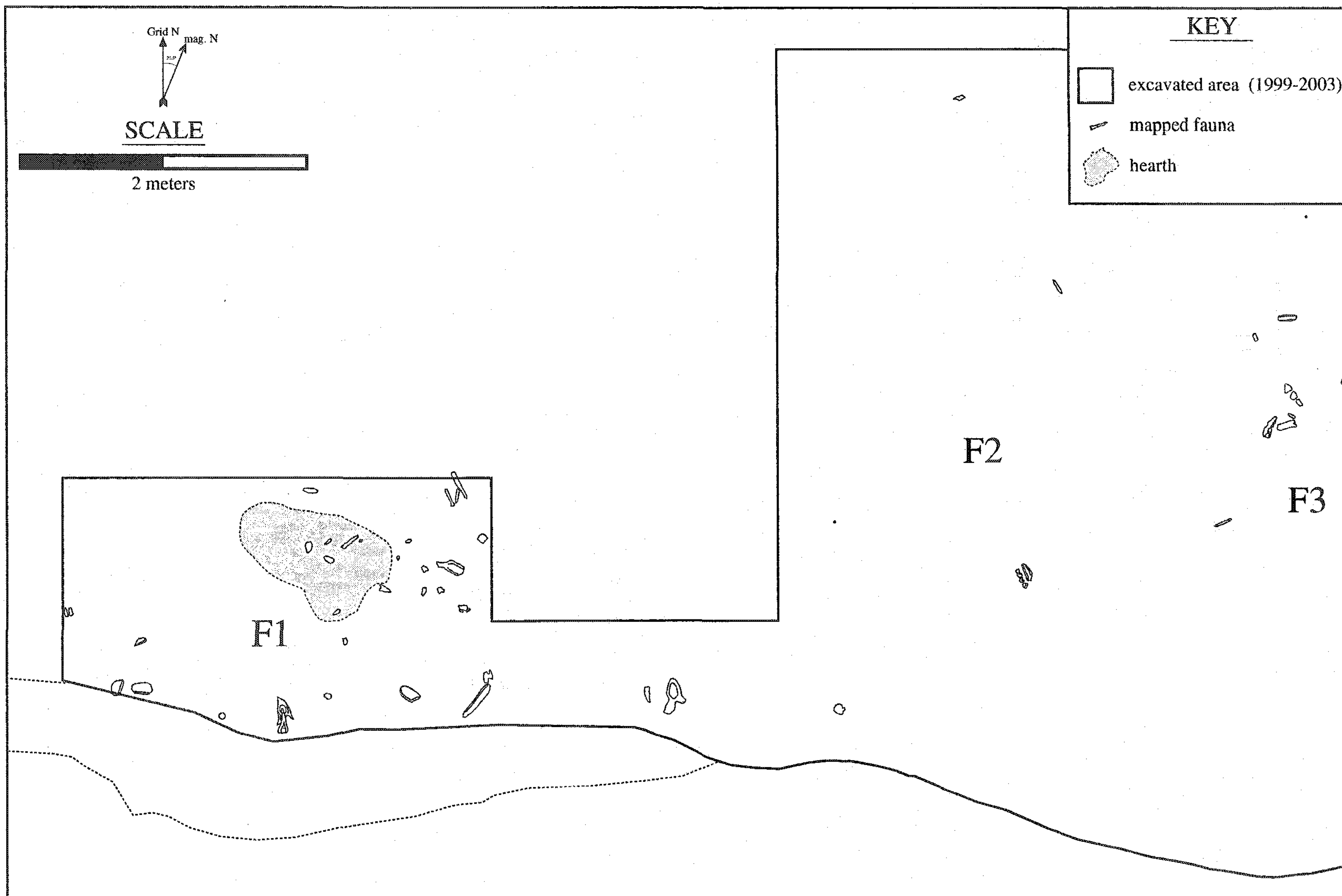


Figure 6.10 Horizontal distribution of faunal remains, western area detail (faunal clusters F1 and F2).

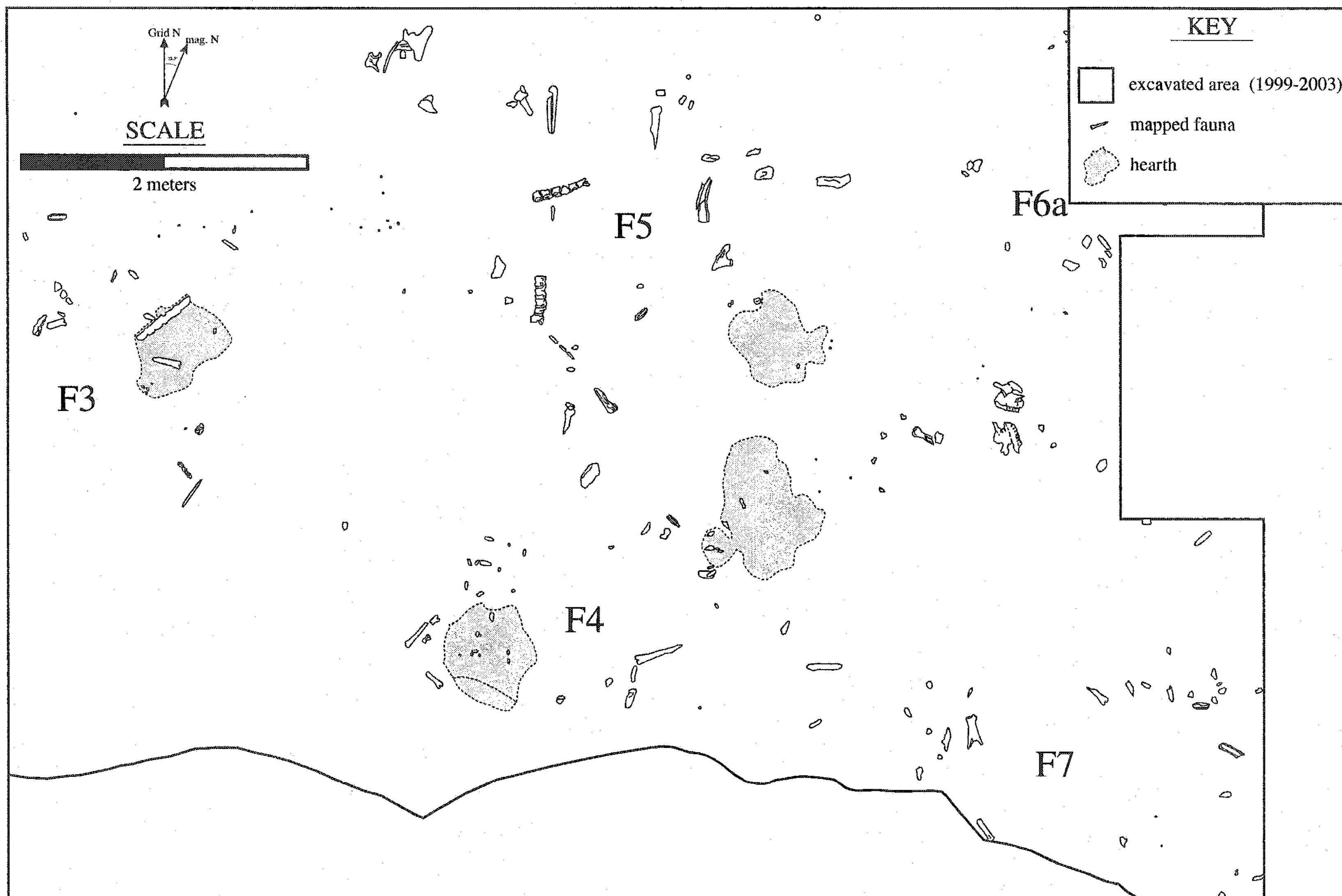


Figure 6.11 Horizontal distribution of faunal remains, main excavation area detail (faunal clusters F3, F4, F5, and F7).

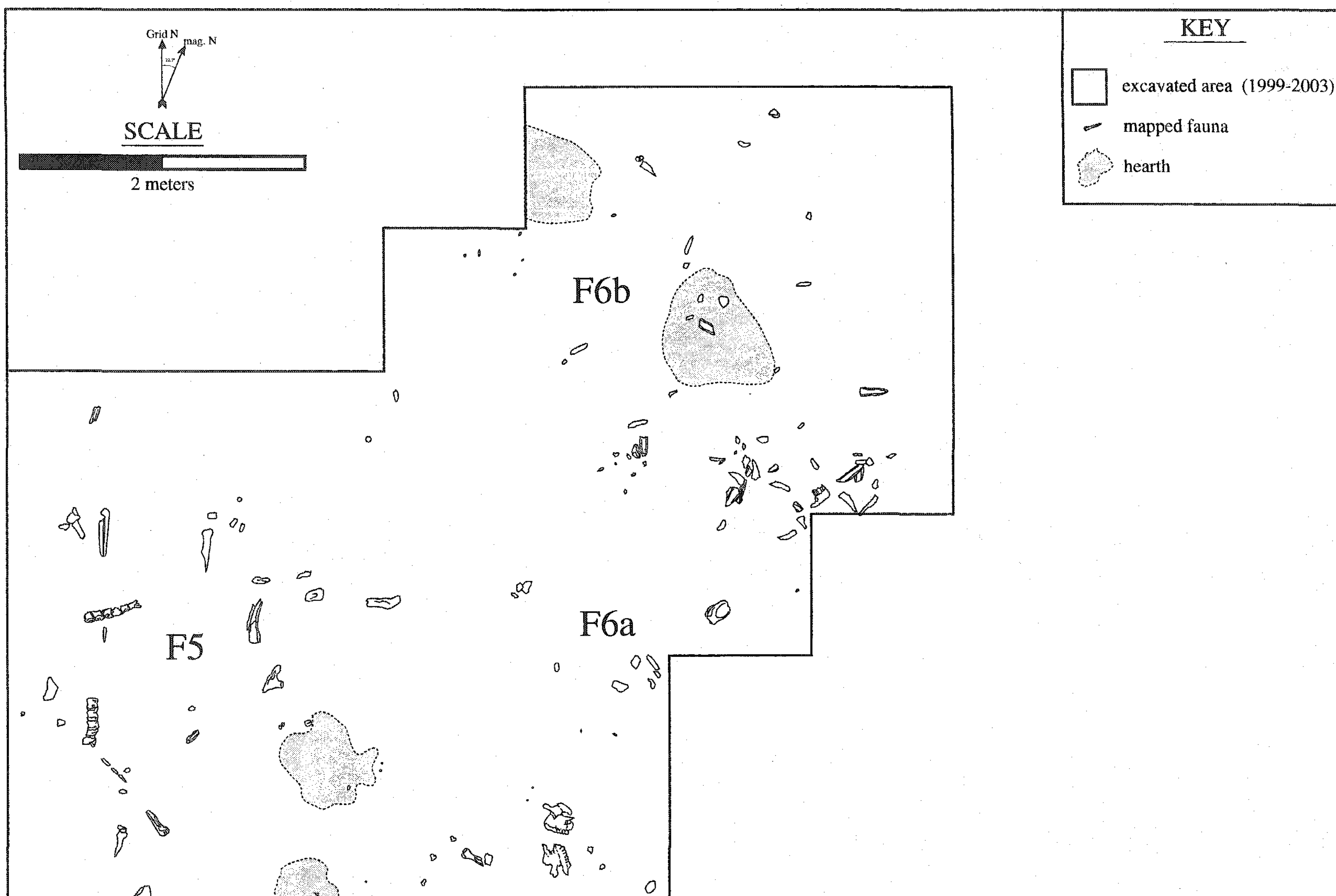


Figure 6.12 Horizontal distribution of faunal remains, northeastern area detail (faunal clusters F6a and F6b).

Figure 6.13 Horizontal distribution of faunal remains, southeastern area detail (faunal clusters F8 and F9).

Figure 6.14 Three-pointed faunal remains and faunal density.

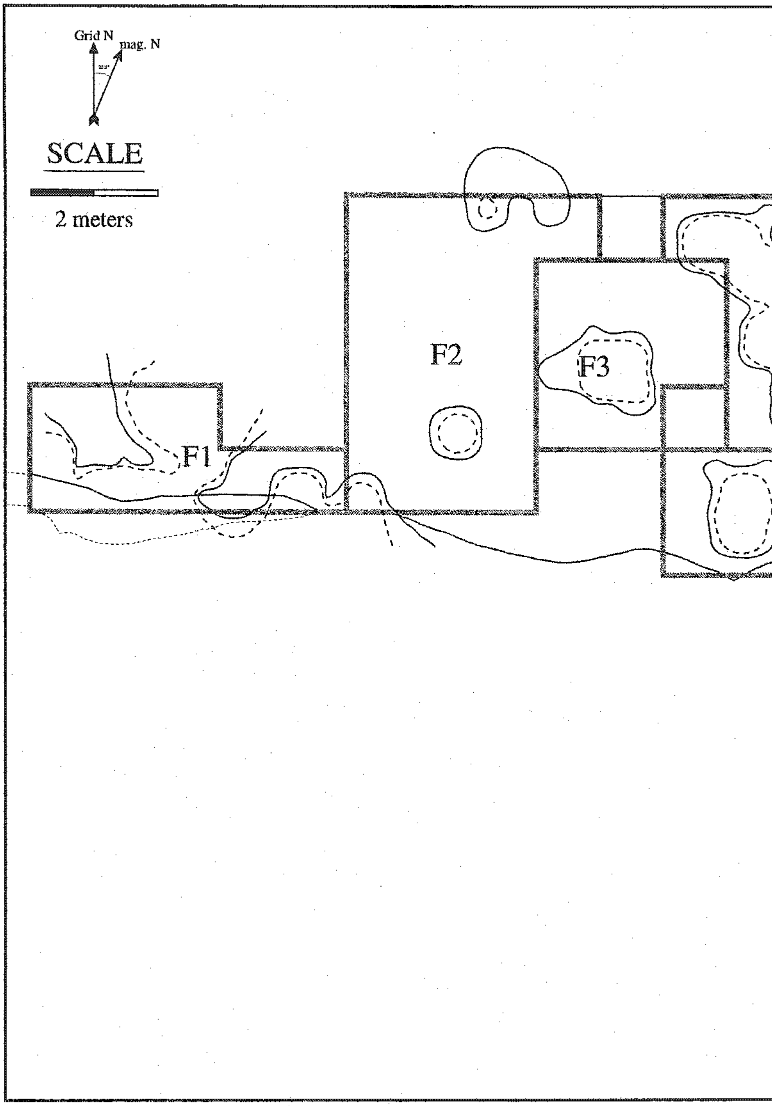
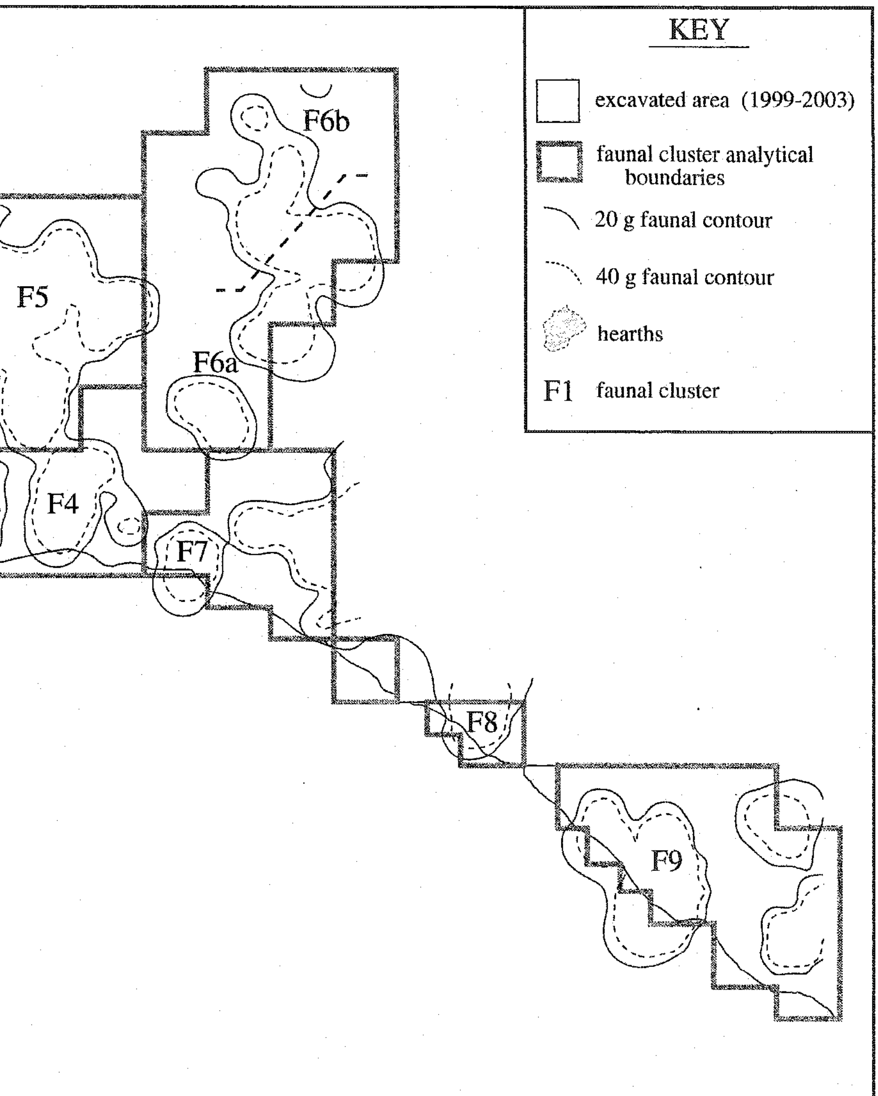


Figure 6.15 Faunal cluster delineation.


KEY
excavated area (1999-2003)
faunal cluster analytical boundaries
20 g faunal contour
40 g faunal contour
hearths
F1 faunal cluster
F4
F5
F6a
F6b
F7
F8
F9

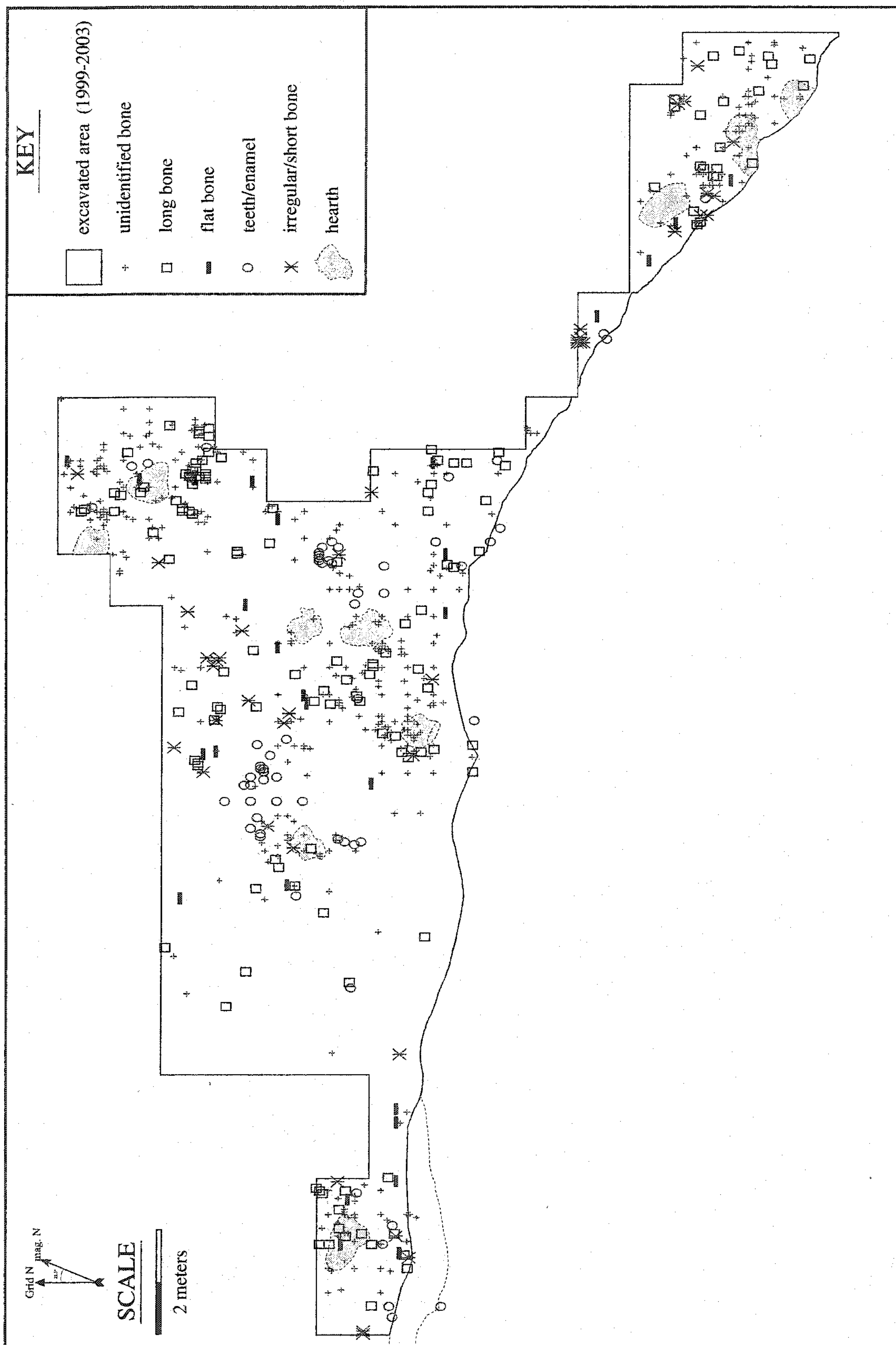


Figure 6.16 Faunal shape distribution.

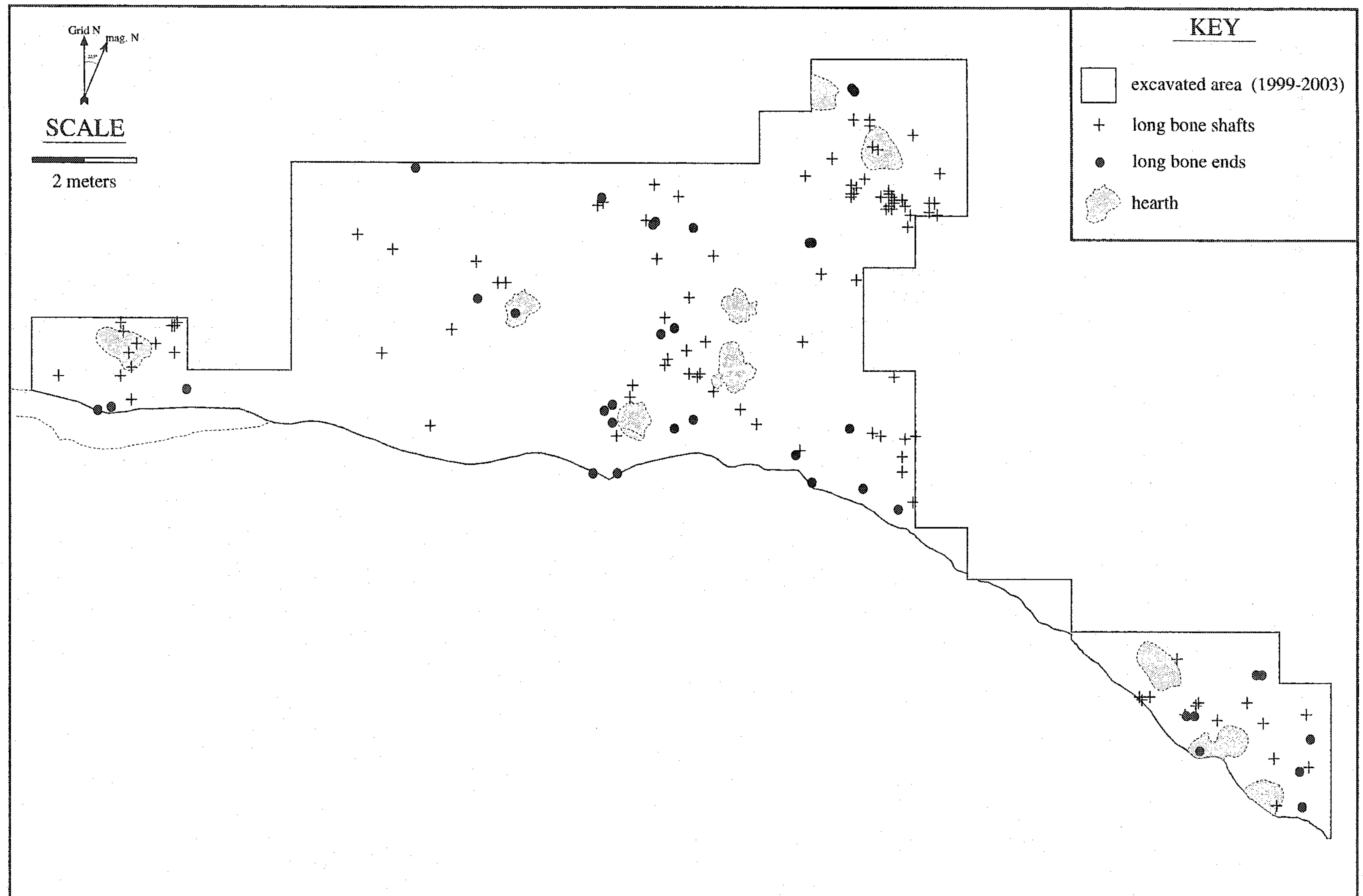


Figure 6.17 Long bone shaft and end distributions.

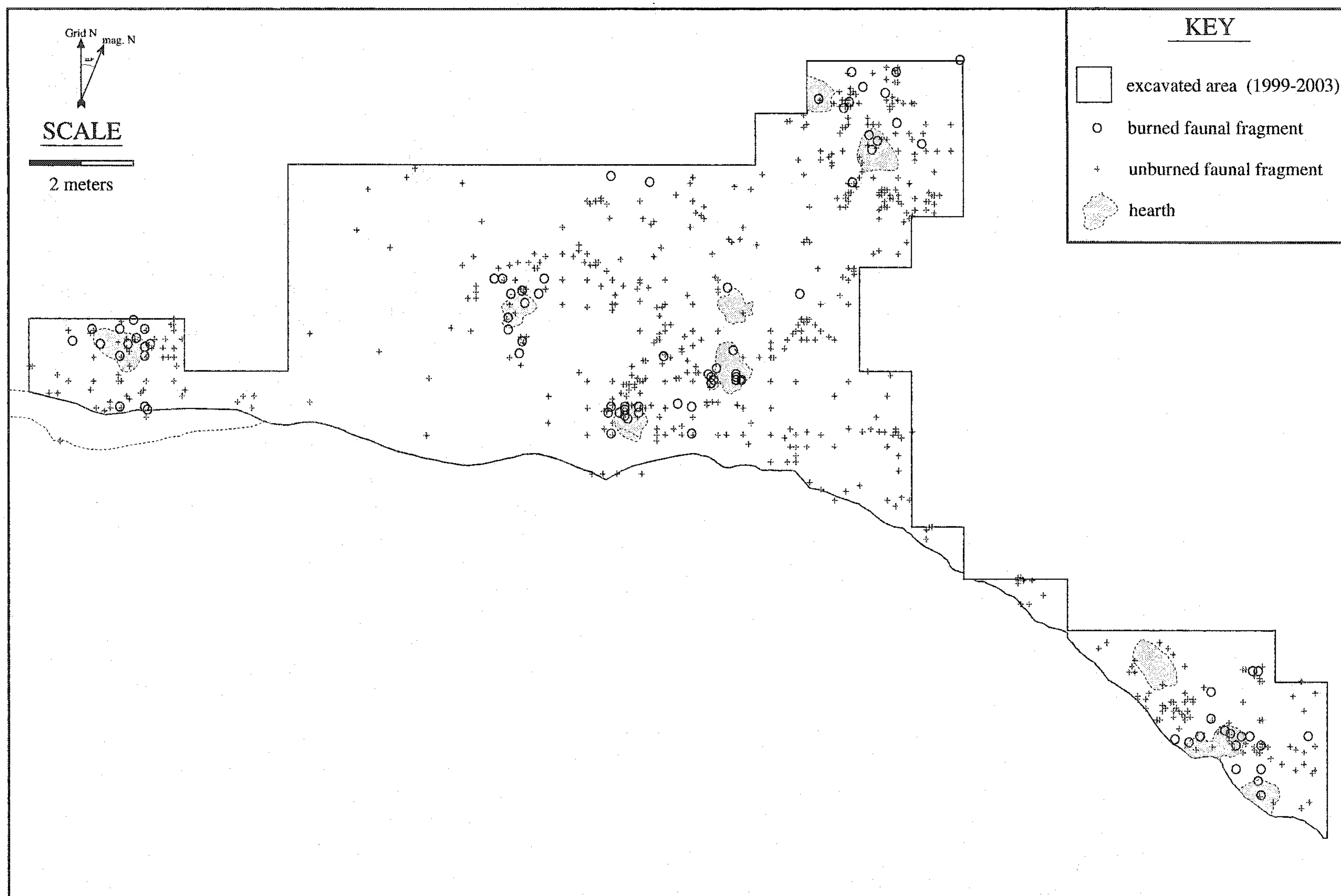


Figure 6.18 Burned bone distribution.

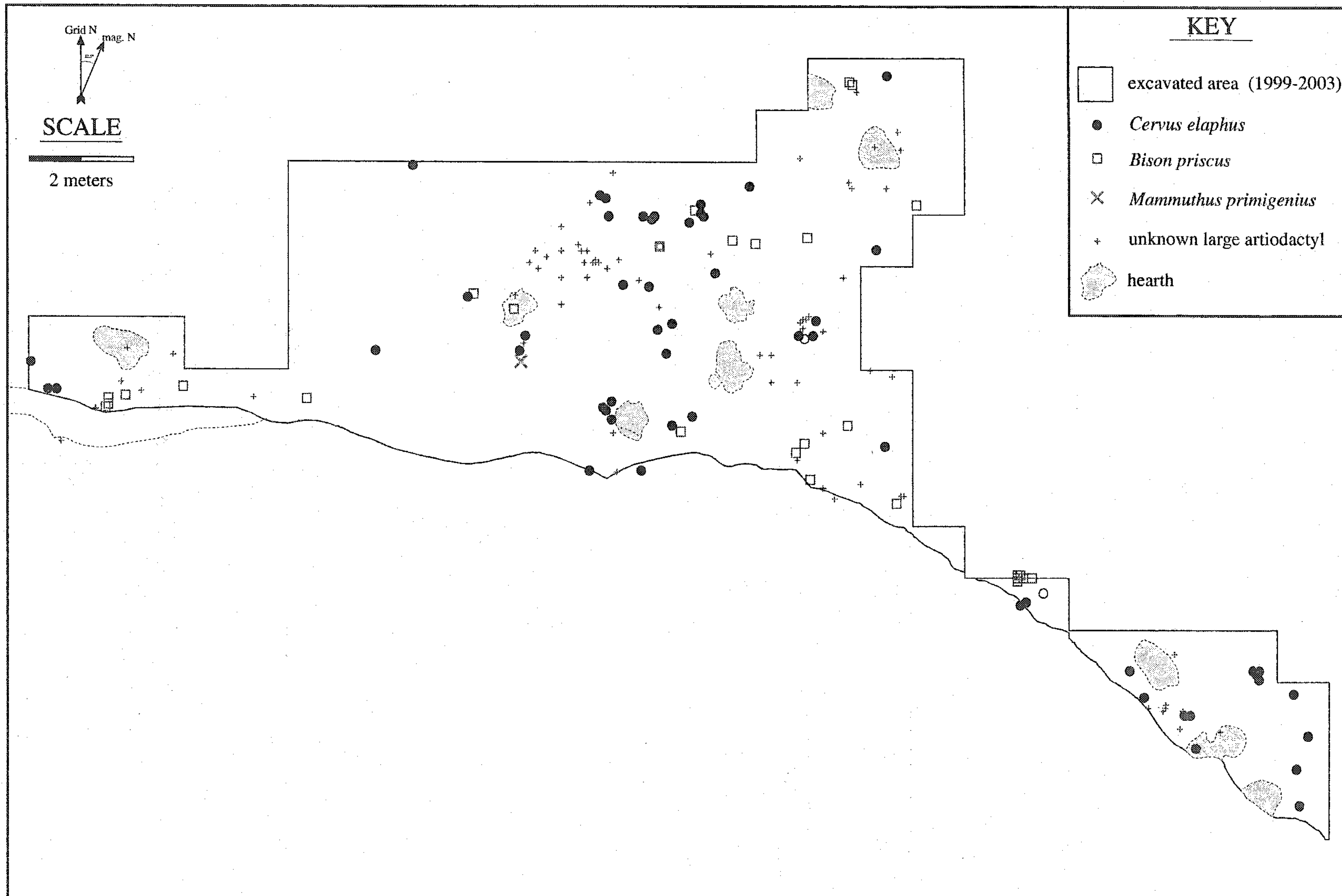


Figure 6.19 Identifiable specimen taxa distribution.

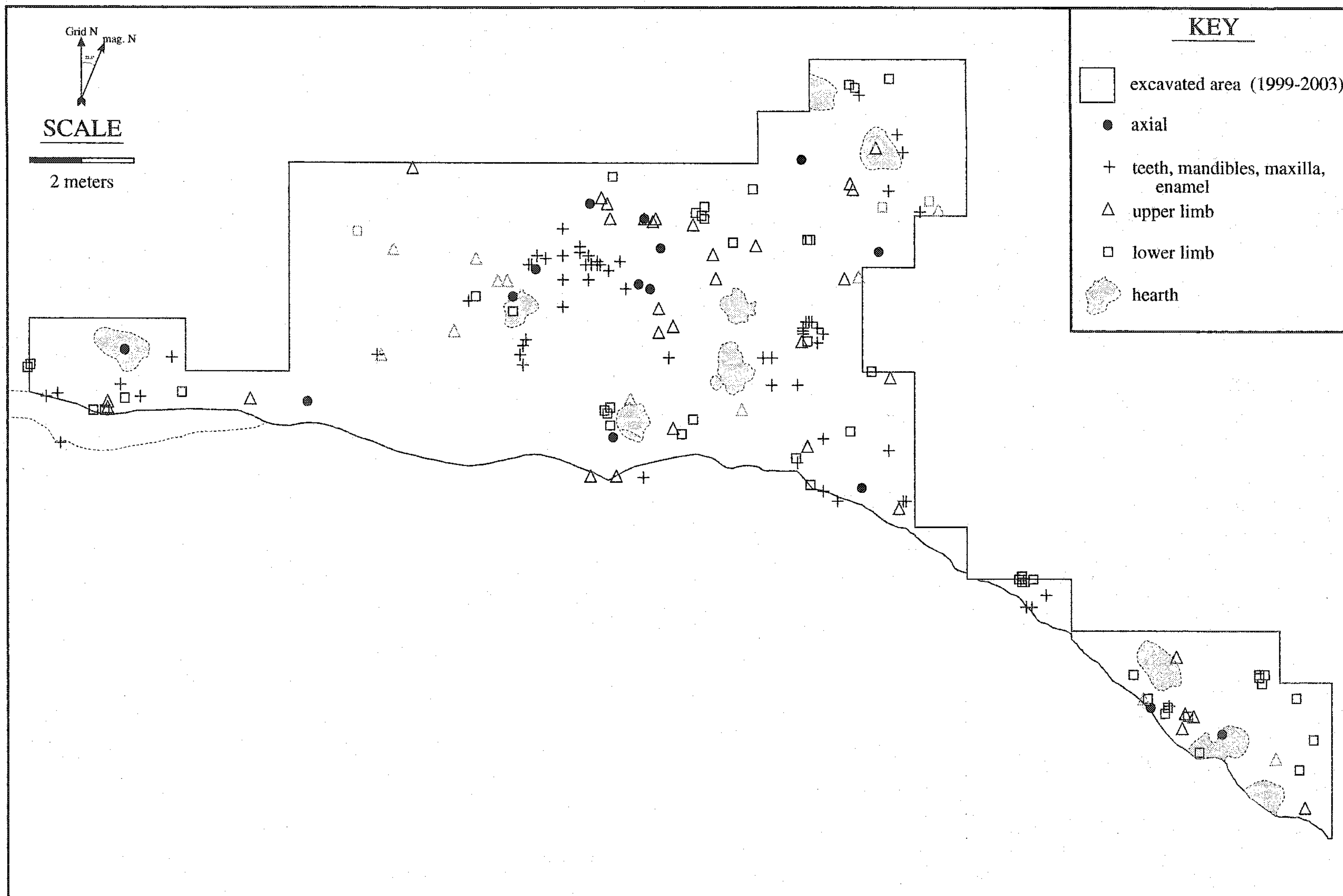


Figure 6.20 Identifiable specimen skeletal unit type distribution (gray symbols indicate tentative identification).

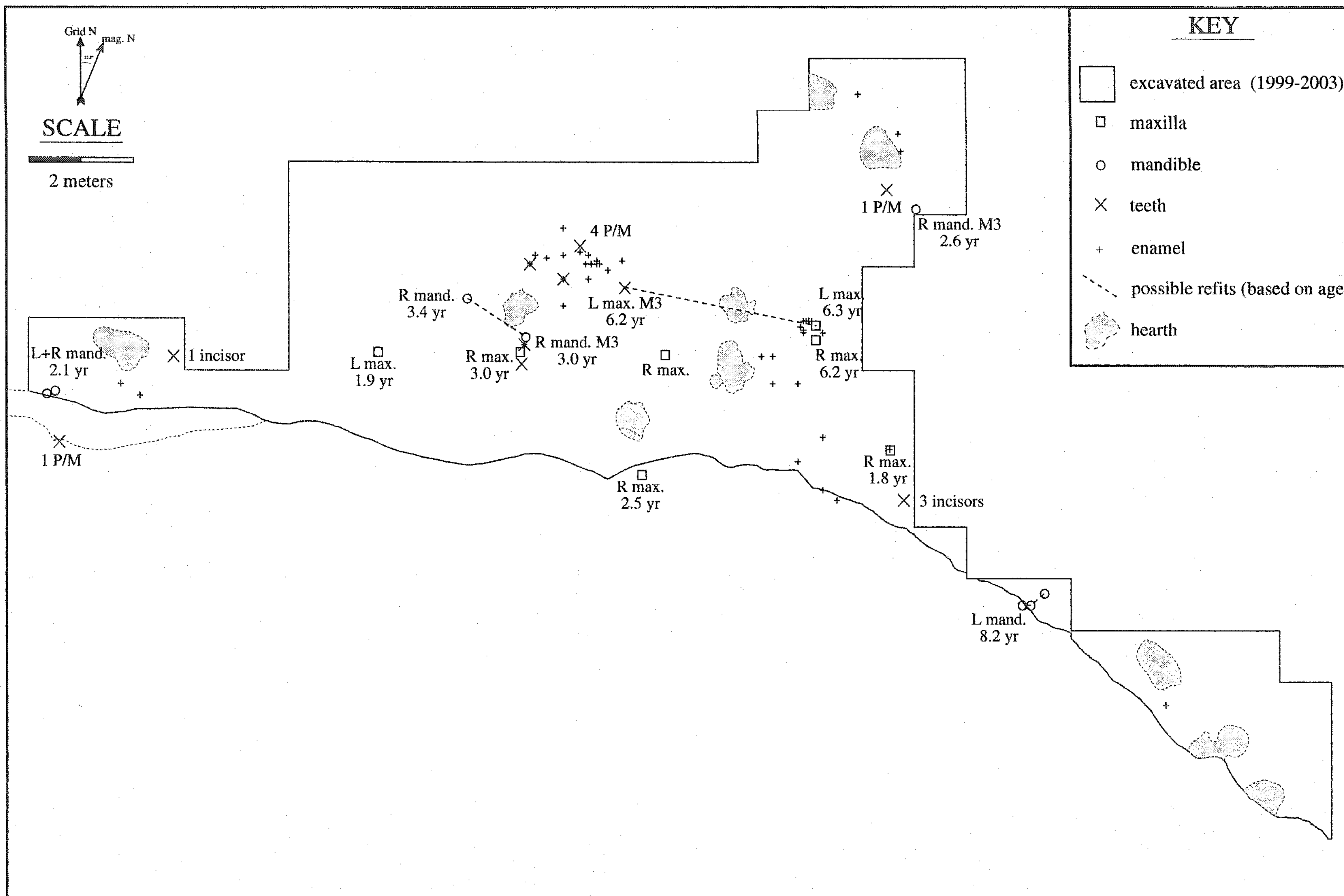


Figure 6.21 Identifiable specimen teeth, enamel, maxilla, and mandible distribution with estimated ages.

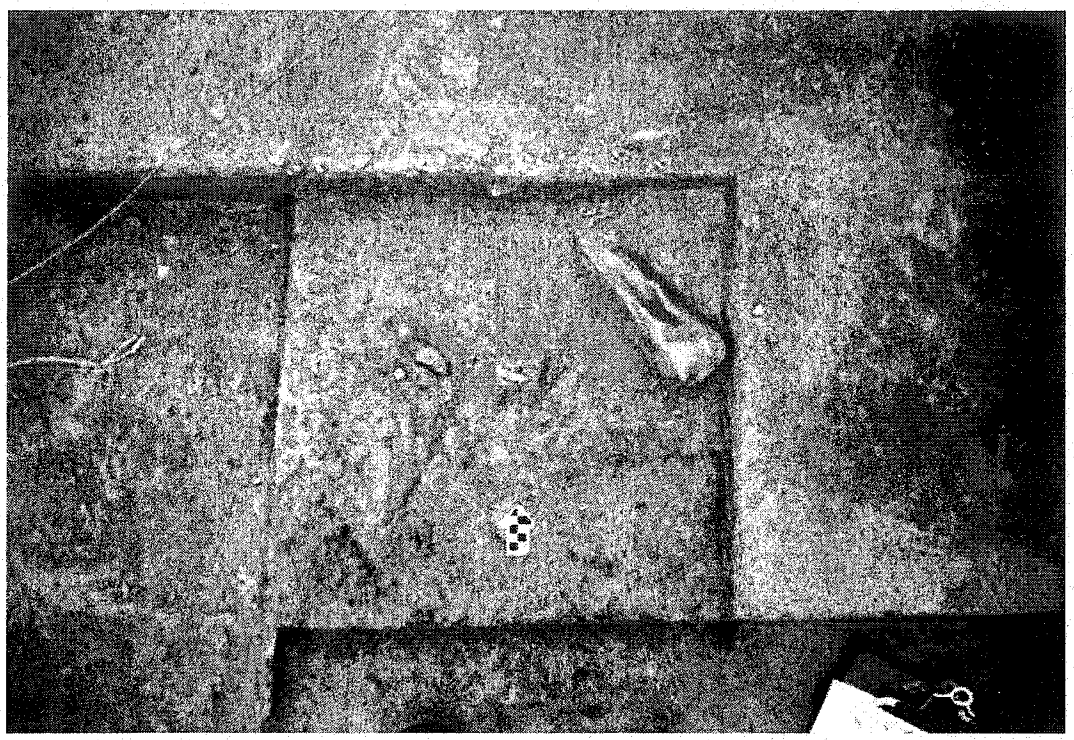


Figure 6.22 Faunal cluster F4 detail (2001) (note lithic artifacts), grid north at top of image.

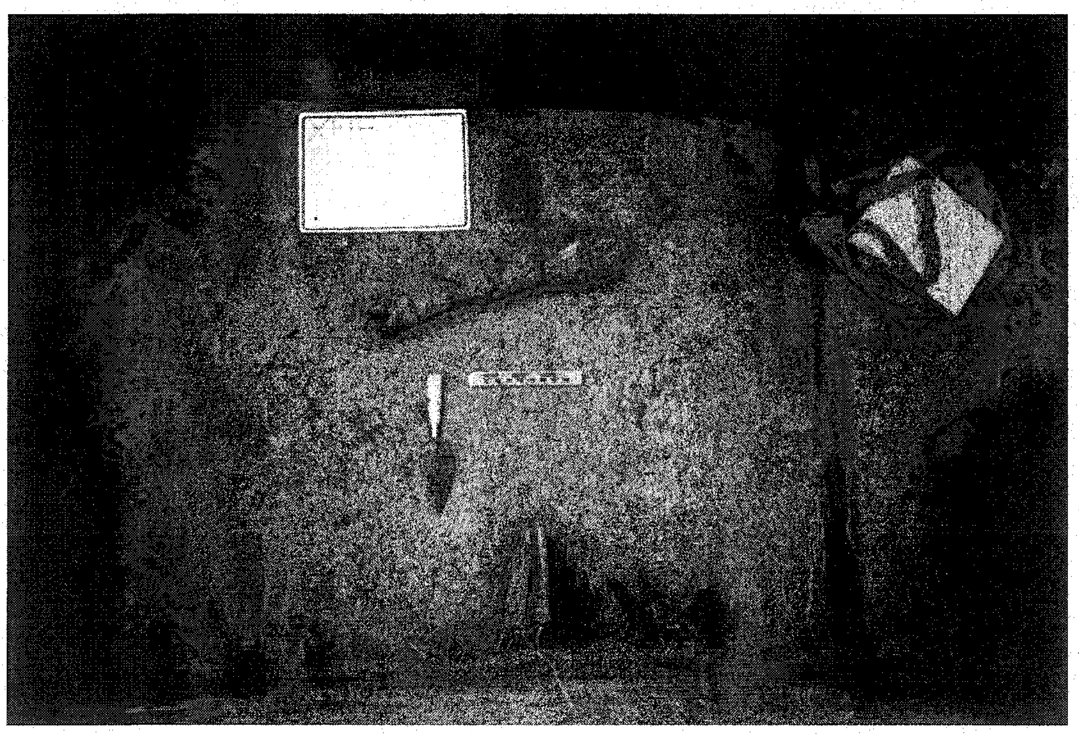


Figure 6.23 Faunal cluster F5 detail (1999), grid south at top of image.

Figure 6.24 Faunal cluster F6a detail (2002), view grid northeast.

Figure 6.25 Faunal cluster F7 detail (1999), grid west at top of image.

Figure 6.26 Faunal cluster F8 detail (2003), view grid north.

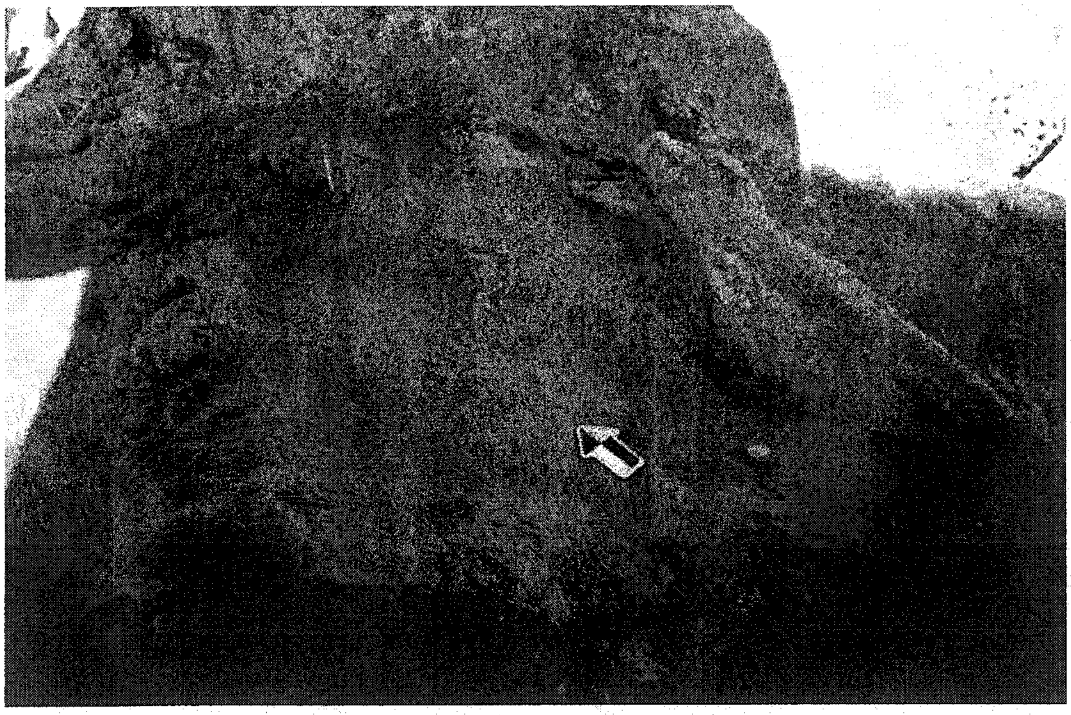


Figure 6.27 Faunal cluster F9 detail (2002), view grid northeast.

Lithic and Feature Co-Presence

Faunal clusters exhibited significant patterning based on association with lithic concentrations and features. For faunal clusters directly associated with lithic concentrations and features, average weight is relatively low, long bones are generally prominent (54-72% of total weight), burn weights are relatively high (3-41%), skeletal unit type is dominated by limb bones. Interestingly, in areas where faunal remains co-occur with lithics and features, fragmentation levels are generally high, with nearly complete elements and smaller fragments interspersed. However, in areas where only faunal remains occur, the fragmentation values are generally low, suggesting that these areas may have been used in such a way as to result in homogeneous fragmentation patterns. Both areas with high levels of articulation (Cluster F5 and F8) are in areas without lithics and features. Clusters F2 and F7 have no articulated specimens, whereas those clusters associated with lithics and features have moderate articulation levels (except F3 and F6b that have high and low articulation levels respectively). This patterning could indicate different processing activities in F1, F3, F4, and F9 vs. F2 and F7. The trimodal articulation %NISP wt. values (0, 12-17, 40-41) suggests that different processing modes occurred within spatially segregated portions of the site.

In areas devoid of lithic concentrations and features, %NISP wt. is considerably lower (51±6 [excluding F5] vs. 69±9), though cluster F5 had by far the highest value (91). This pattern supports a demarcation between F5, which is characterized by articulated, non-fragmented, diagnostic faunal remains and F2 and F7, which are characterized by unarticulated, fragmented, unidentified faunal remains. This pattern also suggests that faunal clusters found associated with lithics were typically more fragmented. %Lower limb and %upper limb weight differences show similarities in clusters F3, F4, and F9 with a predominance of lower limb bones, where F2, F6b, and F5 show a predominance of upper limb bones. Clusters F1 and F7 show an even representation of upper and lower limb bones. In general, %lower limb weights were relatively higher in areas associated with lithic concentrations and features (51±19 vs. 18±21) and %upper limb weights were relatively higher in clusters devoid of lithics and features, suggestive of different processing in these areas. Specific differences among clusters are examined in the next sections.

Weight and Density

The highest faunal density and largest (in terms of area) faunal concentrations is cluster F5, in Area B, where two articulated lumbar vertebrae columns and other large bone fragments are located. Other areas of high relative faunal density are within cluster F1, F3 and F9. The heavier and larger faunal remains are typically found in relatively small concentrations (see Figures 6.9-6.13), most commonly centered on hearths (cluster F3, F4) or very near hearths (cluster F1, F6, F9).

Number of fragments, total weight, average weight per fragment, density (by number of fragments and by weight) were compared for each cluster. Most of these categories showed little relative differences, only average weight per fragment showed significant differences ($U=2$, $p=0.049$). Two clusters had relatively higher average weights than the others (13-20 g vs. 2-6 g), F2 and F8. Both of these clusters are characterized by a relatively few number of fragments (13 and 28 vs. 268-936) and neither were associated with lithics or features. In general, the clusters associated with lithics and features had smaller average weights per fragment (2.2±1.3 g vs. 10.6±7.5 g), suggesting more intensive processing associated with skeletal elements in these areas.

Density (total faunal weight/m^2) ranged from 80.0 to 275.1 g per m^2 and were relatively similar for each cluster except for F1 and F5. For F1, this likely relates to the limited excavation area, but for F5, the density is significantly greater given the higher frequencies of large articulated elements than for the other areas. Two other groups can be discerned: F2, F3 and F6b have lower faunal densities than F4, F9, F7, and F6a (23.3-80.0 vs. 120.0-156.1). It is unclear how to interpret these differences.

Faunal Shape

All faunal remains were classed by shape, long bone, flat bone, irregular/short bone, teeth/enamel, and unidentified. All three-pointed faunal remains were mapped by shape in Figure 6.16. In general, long bones and teeth/enamel were found clustered, whereas flat bones and irregular bones had more dispersed distributions.

For faunal shape (Figure 6.16) two groups were formed: (A) F2 and F5 and (B) other clusters. Group B had higher long bone values than Group A (54-71% vs. 42-43% of total fragments) and lower irregular bone percentages (2-16% vs. 23-35%). Flat bone and teeth percentages were relatively similar, between 1-19% for both groups. Both F2 and F5 were not associated with lithics. Within Group B, F4 and F6b (and to a lesser extent F3) were similar with high percentages of long bones, and relatively high percentages of unidentified bones and low percentages of flat bones. These three clusters are all associated with hearths.

When unidentified bone fragments are removed, four clusters form: (A) F2 and F5, (B) F3, F6a, and (C) F1, F7, F9, and (D) F4, F6b. Group B had high percentages of maxilla/mandible/teeth specimens and low percentages of irregular bones. Group C had high percentages of flat bones, and Group D had very high percentages of long bones and very little else. These patterns generally reflect spatial association with lithics. The most divergent Group (A), F2 and F5 are not associated with lithics, Groups C and D are associated with lithics (except F7). Group B is more difficult to interpret, but the similarities are largely due to high percentages of teeth fragments (making up 22-31% of the identifiable bone types).

Long Bone Shafts and Ends

Long bone shafts and ends were located throughout the site, though some spatial clustering is apparent (Figure 6.17). A large number of long bone shaft-only fragments were situated within Area C (faunal clusters F6a and F6b). Long bone ends generally seem to be spatially disassociated from shaft fragments. For instance, in faunal cluster F1, F4, F6b and F9, where faunal and lithic/feature concentrations co-occur, long bone ends are typically spaced at the periphery of the faunal clusters, whereas the long bone shafts are located more centrally. This patterning may result from differential processing of shafts and end portions in these areas or breaking bones for marrow and tossing the ends away from the processing area. The reverse is the case for cluster F3, where the ends are situated near Feature 1 and the shafts are scattered in the "toss zone" downslope to the west.

For long bone shafts and ends weight percentages (Figure 6.17) two groups were formed: (A) F6a, F6b, F2, F7, and (B) F1, F3, F4, F5, F9. Group A had higher frequencies of shaft fragments than Group B (58-82% vs. 23-34%). Group B contained more shaft fragments with adjoining epiphyses. The faunal clusters associated with lithics generally had higher percentages of epiphyses, except cluster F6b, which had the lowest value of epiphyses (18% of long bone weight). This pattern may be explained by breaking long bones for marrow near the hearths and discarding the epiphyses and shaft fragments there. The more highly fragmented clusters (Group A) may be the result of further processing or discard of shaft fragments after processing in the hearth areas.

Burned Bone

While only a relatively small percent of the total faunal remains in Component 3 were burned (14% by weight), the burned bones are clustered directly in association with hearth features 1, 3, 5, 10, 12, and 14 (Figure 6.18). In other areas, almost no burned bone was recovered. In terms of burned bone dispersion, Features 3, 5, and 10 showed the lowest dispersal (assuming all burned bones were originally within each respective hearth. Features 1 and 14 showed moderate dispersion whereas Feature 12 showed the highest dispersion, suggesting the latter area may have had more disturbance relating to burned faunal discard. Hearths 9, 13, 16, and 18 had little or no directly associated burned bone and their function may have been different than those hearths with associated burned faunal remains. Charcoal cluster features 8 and 11 have no associated burned bone.

For burning types three groups were formed: (A) F2, F3, (B) F1, F4, and (C) F5, F6, F7, F9. Group A is the most divergent in having relatively low unburned bone frequencies (17% average vs. 86% average for the other clusters), though F3 has much higher black charred percentages than F2 (34.8% vs. 0.0%). Group B has relatively higher percentages of calcined bone (2% vs. 0.1% for Group C). Group C has low frequencies of calcined and black charred bone, and high percentages of unburned bone (84% average), though F9 is the most divergent from this group, having higher burned bone percentages (calcined, black charred, and brown charred). The similarities in F2 and F3 could be explained by F2 functioning as a "toss zone" downslope from Feature 1, associated with faunal cluster F3, where F3 was the "source" of bones found within F2.

For burned vs. unburned weight percentages (Figure 6.18) three groups were formed: (A) F2, F3, and F5, the most divergent, (B) F1, F6a, F9, and (C) F4, F6b, F7. Group A has the highest weight percentages of burned bones (32% average, ranging from 22-46%), Group B has intermediate percentages of burned bones (12% average, ranging from 9-14%), and Group C has the lowest percentage of burned bone (3% average, ranging from 0-7%). This distinction in terms of burning on site is linked spatially as well. Clusters with high burn frequencies (Group A) are situated adjacent to each other centered around Feature 1. The unburned clusters (Group C) are situated adjacent to each other to the south and east of Group A. The intermediate clusters are located in the periphery of Group A to the west, northeast and extreme southeast. This patterning in burn intensity may indicate intrasite differences in processing faunal remains. Clearly, each faunal cluster cannot be treated as if they were the result of homogeneous taphonomic processes. When F6 was divided into F6a and F6b, the former, not associated with lithics or features had almost no burned bones (0.1%), whereas F6b, associated with Feature 12 and Area C, had 5.4% burned bone weight. F3 had a larger percentage of burned bone weights (46% compared with 22%-28% of the others in Group A), largely due to articulated vertebrae (brown-charred) situated on the north side of Hearth Feature 1.

Taxa

The three taxa present in Component 3, bison, wapiti, and mammoth, are distributed in patterned ways across the site, though there is considerable intermixture in certain locations (Figure 6.19). Bison remains are situated in three areas, generally in different areas than the wapiti, though there are areas where they overlap or come together. One bison area is within F1 and Area A. The second bison area is located within clusters F5 and F6 near Area C and Subarea B4. The third bison area coincides with cluster F7 and F8. The wapiti remains are found in three groups. The largest by far is situated in Area B, and is associated with faunal clusters F2, F3, F4, and F5. The second wapiti area is associated with cluster F8 and F9 and Area D, to the east of the bison area. The third wapiti area is associated with cluster F1 and Area A, to the west of the bison area. Bison and wapiti overlap within faunal clusters F3, F4, F5, and F6. A single worked mammoth ivory rod or point was found within cluster F3.

For NISP and non-NISP weight percentages (Figure 6.19) three groups were formed: (A) F1, F4, F9, (B) F2, F6a, F6b, F7, and (C) F3, F5. Group A had high percentages of NISP weights (67-73% of total weight), Group B had lower percentages (44-56%), and Group C had very high percentages (81-91%). These patterns appear to be related to association with lithic and feature concentrations. All faunal clusters associated with lithics and features (except F6b) have high NISP weight percentages (Group A), whereas the faunal clusters outside these areas are either low (Group B) or very high (Group C). F5 is clearly the most divergent, in that within a large amount of faunal remains in a completely excavated cluster has very high NISP weight percentages. The grouping of F6b with non-lithic faunal clusters (F2, F6a, F7) suggests that either (1) the faunal remains in F6b may be the result of processes similar to those in the other clusters, or (2) the northern boundary of F6a may intrude into the lithic concentration and features, with larger fragments associated with F6a masking the smaller fragments associated there. The associated hearth features, Features 9, 12, and 18 do not contain calcined bone and very small amounts of black charred bone. The differences between this group of hearths and the hearths that do contain significant amounts of calcined and black-charred bone (Features 1, 3, 5, 10, and 14, associated with faunal clusters F1, F3, F4, and F9) could suggest a relationship between these hearths and the relative lack of identifiable specimens. The same taphonomic process could relate these two patterns.

For NISP weight percentages by taxon (bison, wapiti, mammoth, unknown artiodactyl) (Figure 6.19), two groups were formed: (A) F2, F4, F5, F9, and (B) F1, F3, F6a, F6b, F7. Group A has low unknown artiodactyl NISP weight percentages (0-33%) and high wapiti NISP weight percentages (58-68%), and Group B has high unknown artiodactyl NISP weight percentages (41-82%) and low wapiti NISP weight percentages (5-29%). Bison NISP weight percentages varied widely for each group. F1 is somewhat different from others in Group B with lower unknown artiodactyl percentages (41% vs. 63-82%). For bison and wapiti NISP only, excluding unknown artiodactyls, the same two groups were formed (see Figure 6.7). This patterning suggests that bison were scattered more widely throughout the site in low relative percentages (to wapiti and unknown artiodactyls).

MNI of bison and wapiti (Figure 6.19) were calculated for each faunal cluster sub-assemblage. Bison MNI ranged from 0 to 2, wapiti MNI ranged from 1 to 2. Most clusters contained remains from one bison and one wapiti individual (n=6, 67%), where F9 contained a minimum of two wapiti, F7 contained two bison and one wapiti, and F5 contained two wapiti and one bison. It is therefore possible that different faunal clusters represent single events where anatomical portions of two to three animals were brought to the site and were further processed. The similarity in MNI values for each cluster and the ratios with total assemblage MNI values (seven clusters with 25% of total MNI, two clusters with 38% of total MNI) suggests that between two and three kill and transport events took place within this component.

Skeletal Unit Types

Skeletal unit types exhibited clustered distributions within Component 3 (Figure 6.20). Teeth, mandible, maxilla, and enamel fragments were generally found clustered together at some distance from other skeletal unit types, generally in areas between hearths. Long bones were more typically found nearer to hearths. Upper and lower limb bones were found near each other, and no spatial discrimination was apparent, though the lower limb bones were in a less fragmented state (see below). Axial element portions seem to be limited to cluster F5, though a few are found adjacent to this area, in F3 and F6. This limited distribution of axial element portions suggests that the area associated with cluster F5 functioned in a different way within the processing trajectories at Gerstle River Component 3 occupation(s). The central location relative to the peripheral faunal clusters (and hearth areas) suggests a staging area or meat processing area rather than a specific marrow extraction area. The relative lack of fragmentation and higher articulation within cluster F5 (see below) supports this hypothesis.

For skeletal unit type percentages (Figure 6.20) three groups were formed: (A) F1, F4, F6b, F7, F9 and (B) F2, F3, F6a, and (C) F5. Group A was dominated by lower limb bones (53% average) and upper limb bones (38% average) and lower percentages of teeth (6% average) and axial bones (2% average), whereas Group B contained higher percentages of axial bones (39% average) and teeth (33% average) and lower percentages of lower and upper limb bones (17% and 11% averages respectively). Group C (F5) was the most dissimilar of all clusters, with very few lower limb bones and teeth (8% and 3% respectively) and much higher frequencies of upper limb bones (59%). An interesting linear separation is seen when comparing Groups A and B on the site map (Figures 6.9, 6.14, and 6.15). Group A is situated along the periphery of Group B. This may indicate differences in faunal processing that could result in long bones being deposited near hearth areas after marrow extraction, whereas axial portions were left generally articulated to the north with relatively little or no processing. The large area relatively clear of lithic items between Features 1, 3, and 12 and the presence of a group of articulated lumbar vertebra and other articulated elements support this scenario. For appendicular vs. axial skeletal units (skeletal unit type 2) (Figure 6.7), a similar pattern emerges, with clusters F1, F4, F6b, F7, and F9 dominated by appendicular elements and clusters F2, F3, F5, and F6a dominated by axial elements.

Articulation

The minimum level of articulation necessary for classification as articulated is defined as where element portions are 0-5 cm apart in their natural anatomical positions (NISP=39) or where element portions are 5-50 cm apart in their natural anatomical positions and/or adjacent but not in their natural anatomical positions (NISP=9) (see below). For articulation, three groups are formed: (A) F3, F5, (B) F2, F6b, F7, and (C) F1, F4, F6a, F9. Group A had very high levels of articulation (41% of total NISP weight and 35% of total weight), Group B had no articulated specimens, and Group C had low levels of articulation (14% of total NISP weight and 9% of total weight). Cluster F3 is skewed due to the presence of a single group of articulated vertebra in Feature 1, and when this is removed, there are no articulations present. Cluster F5 stands apart from the other groups in its high levels of articulation, including not only two articulated lumbar vertebrae columns (combined MNE=11), but also two radii-ulnae and three phalanges in close association (combined MNE=7). Interestingly, two of the three other clusters not associated with fauna have no articulations (F2 and F7), suggesting that these may represent bone dumps or discard areas.

Spatial Summary

The results of this spatial analysis show that considerable spatial and perhaps functional patterning is evident within Gerstle River Component 3. In order to assess overall variability between the faunal clusters, another hierarchical clustering was conducted, using co-occurrence with lithic concentrations, average weight, weight density, %shaft weight, %faunal shape, %burned, %skeletal unit type, %articulated total weight variables (transformed to z-scores) (Figure 6.8). Three groups were formed: (A) F1, F4, F6b, F7, F9, (B) F2, F3, F6a, and (C) F5. Within Group A, bone marrow extraction from long bones is hypothesized, and all are directly associated with features and lithic concentrations (except F7). F7 may represent a disposal area where the "source" is F4, located directly to the west of F7. Within Group B, two of the three clusters are not associated with lithics or features (F2, F6a) and may represent discard areas. The inclusion of F3 within this group is likely due to the presence of teeth and articulated lumbar vertebrae, which elevates %axial and %teeth. Cluster F5 is clearly the most divergent from all of the other clusters in many ways. Cluster F5 is characterized by high abundance of large, mostly articulated specimens (high average weight and weight density), low %shaft weight, high %irregular bones, high %NISP weight, and the most mixed in terms of skeletal unit type. While the other clusters had predominantly axial or predominantly limb bones, F5 (and F2) contained both at relatively high levels.

On the basis of the spatial patterning, cluster F5 is the most divergent, with characteristics described above. Clusters F1, F4, F9, F6b, and to a lesser extent F3 (all associated with features and lithic concentrations) share certain characteristics. Fragmentation (on the basis of average fragment weight and %unidentified faunal shape weight) is high, average weight is low, with low articulation but high %NISP weight, and high %burned weights. These clusters are generally dominated by long bones (except F3).

Clusters F2 and F7 are interpreted to be disposal areas on the basis of lack of fragmentation, lack of articulation, and lack of associated lithic concentrations or features. These clusters are similar in high average weights, high %shaft bone weight, lack of any burned bone, and low %NISP weight. Significant differences exist, and these are possibly due to different "sources" of processing areas for these dumps. F2 has fewer long bones and more axial bones and teeth relative to F7, and these differences are shared by their adjacent processing areas (F3 and F2, and F4 and F7). Given these similarities, F3 could be considered the source of F2 materials, as F2 is located just west and downslope from F3 and could be considered a toss zone. F4 could be considered the source of F7, which is also located downslope from F4. Both F2 and F7 are situated in the periphery of the main activity areas (Area B), which further supports this hypothesis.

The last cluster considered here, F6a, is somewhat ambiguous. It shares some characteristics with the F5 hypothetical staging area such as higher average weight, relatively low %long bone weight, low %burn weight, high %axial weight, and relatively high %articulated NISP weight. However, it shares other characteristics with the disposal areas described above, such as low %burn weight and low %NISP weight. Two distinct areas are encompassed within cluster F6a, a dense concentration of long bone shafts just south of cluster F6b, and a concentration of maxillae and teeth fragments north of cluster F7. It is possible that these two areas represent different activities. Given the patterns observed above, the northeastern concentration of long bones could represent a marrow processing area and the southern area could represent part of a disposal area where cranial and teeth fragments were discarded.

Weathering

As noted above, the bone preservation at Gerstle River Component 3, while extraordinary relative to other central Alaskan sites, is considered poor. The bones, with the exception of compact bones like phalanges, carpals, and tarsals, are extremely fragile, and are generally falling apart *in situ*. Great care was taken to record condition with photography and plan drawings prior to excavation. Post-depositional breakage was quite common, and was noted. Weathering stages for each bone were not systematically recorded, as they generally poorly preserved, ranging from Stages 4 to 5, with most in the latter stage, (Todd et al. 1987; Behrensmeyer 1978). Stage 4 bones are characterized as having weathered, rough surfaces (coarse, fibrous texture), cracked and rounded edges, with penetration of weathering into inner portions of the bones. Stage 5 bones are characterized as "falling apart *in situ*," (Behrensmeyer 1978:151). The very few Stage 4 bone fragments were all found within faunal cluster F5, an area characterized by articulated specimens (see below). A precise nature of the weathering is described below. Teeth are in a more preserved state than the bone, and mandible and maxilla fragments directly associated with teeth show the same deterioration evident in other bones in this component. The most common elements of weathering includes root (or acid) etching, mosaic flaking and exfoliation, longitudinal cracking, and staining. All of the bones exhibit some degree of surface erosion, and the outer surface of the majority of the bones exhibit a coarse fiber-like texture (Figure 6.28 lower). Table 6.7 lists the weathering type by weight for all faunal remains within Component 3. Percentages exceed 100% due to multiple weathering types per provenience unit.

Table 6.7 Weathering types by weight.

Weathering Type	*Total weight (g)*	*Percent of total weight*
root etching	11713.5	97.1
longitudinal cracking	1089.2	9.0
surface flaking, mosaic flaking	792.9	6.6
indeterminate	364.0	3.0
erosion/abrasion	48.5	0.4
bleaching	23.5	0.2

The sediment directly surrounding the bones (up to 2 cm) were stained to a homogenous light gray, rather than the mottled yellow silt of stratum Y4. This staining could be the result of *in situ* bone decomposition. Most of the faunal remains recovered were solid material, and only 33 provenience units (4% of total) were what have been termed "bone smears" by Guthrie at Dry

Creek (1983a:217). At Gerstle River however, these fragments were collected and are added into the analysis. Most contained very tiny, fragile bone fragments. These were assigned a weight of 0.1 g and a number of fragments of 1 for analytical purposes (see above).

Root etching, or more precisely, etching of the faunal remains by means of humic acid excreted from plant roots is the most common weathering condition observed in these faunal remains (see Lyman 1994a:375-377; Fisher 1995:43). Remnants of small roots and rootlets are generally found interspersed throughout the surface of the bone and teeth specimens and throughout the cancellous (trabecular, or spongy) bone portions. Robust lamellar cortical bone is the least affected, whereas the cancellous bone is the most heavily affected. The rootlets generally lie on the surface of long bone shaft fragments, and some differences are apparent, perhaps as a result of spatial distribution. Long bones found within faunal cluster F5 are generally less affected by root etching, whereas those from faunal cluster F7 are more heavily affected, and in some cases, long bone shafts have cavities apparently formed through extensive root etching and/or other weathering process (see Figure 6.28, which shows representatives from both clusters). Cancellous bone fragments typically have roots interspersed throughout the bone, resulting in an almost immediate collapse and crumbling of the bone upon recovery and removal to specimen bags or aluminum foil. Mandible, maxilla, innominate, and vertebrae fragments are especially susceptible to extreme friability.

Given the ubiquity and intensity of the bone deterioration, it was difficult to identify cut marks, impact fractures, and other butchery marks on the faunal remains. However, no obvious carnivore or rodent gnawing or furrows was observed on the remains. Until more detailed microscopic examination is attempted, this possible data set cannot be further explored. The absence of well-defined cutmarks, though perhaps due to cortical bone deterioration, is not a necessary criteria for human butchery, as "it is quite possible to butcher an animal of any size without leaving a single mark on any bone" (Guilday et al. 1962:64; see also Lyman 1987:260-281).

Mosaic flaking or surface flaking and longitudinal cracking were present in smaller percentages, and were generally found on slightly better preserved long bones (see Figures 6.1 and 6.28). These patterns may also be caused by root action after burial (see Behrensmeyer 1978:154). Many long bone fragments and larger bone fragments were falling apart *in situ*, and the long bones typically fragmented in longitudinal pattern.

In general, there was no difference in weathering patterns on lower or upper surfaces, and no concretions were noted. Weak staining (pale yellowish brown to pale brown, 10YR 6/2 to 5YR 5/2) was constant and did not vary with respect to lower or upper surfaces. The cause of this staining is at present unknown, though it is considered related to soil properties at the site given its ubiquity. It is important to note that faunal remains from other strata at the site exhibit similar hues, including fauna from the stratum Y2, dating to between 5050 and 6239 BP.

The taphonomic causes of longitudinal cracking and mosaic and surface flaking may be related to wetting and drying of the Y4 sediments. The sediments were likely periodically frozen and thawed, and this action may have led to the weathering patterns observed. The fact that relatively few bones exhibit this pattern suggests that freezing and thawing of the Y4 sediments were probably not extensive, or at least did not affect the majority of the faunal remains. Dessication could also be a factor in the observed weathering patterns. However, the major factor in their deterioration was the actions of roots invading the bone fragments, which resulted in acid etching and further fragmentation.

In assessing taphonomy of an assemblage, it is also important to note the weathering patterns that were *not* observed within the assemblage. No faunal remains exhibited conditions related to passing through the digestive tract of carnivores such as a "dissolved appearance." Polish was not noted, and bleaching and abrasion were very rare, suggesting that the bones were not exposed on the site surface for a relatively long time. Given the variability in fragmentation (from complete long bones to tiny fragments of cancellous bone), and the survivorship of bones with high and low density (see below), it is argued that large scale trampling was not a major factor in the taphonomy of the Gerstle River Component 3 faunal material. Striations, often caused by sedimentary particle abrasion, were not observed, though some striation types are only visible by microscopic examination (see Fisher 1995:33-35).

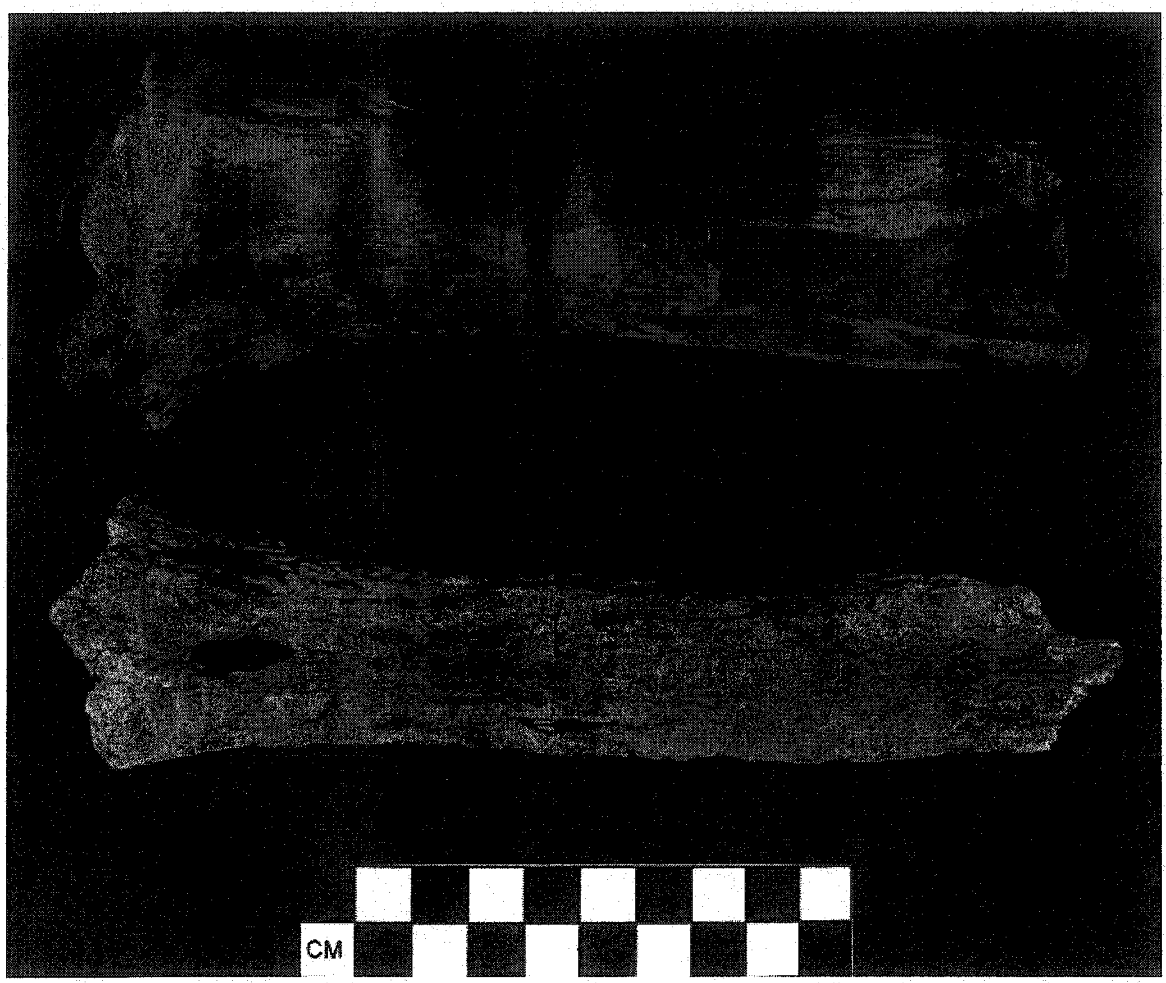


Figure 6.28 Examples of bone weathering of Gerstle River Component 3 fauna. Upper bone fragment, radius (UA99-62-801, wapiti) from cluster F5 exhibits limited root etching and longitudinal cracking (Stage 4). Lower bone fragment, metatarsal (UA99-62-819, bison) from cluster F7 exhibits extensive root etching and coarsely fibrous appearance (Stage 5).

Fragmentation

All of the processes involved in breakage of faunal assemblages may not be known, but documentation of the fragmentation patterns is a necessary first step in evaluating taphonomic processes within a site (Todd and Rapson 1988). Because a large fraction of the Gerstle River Component 3 assemblage is made up of faunal remains unidentifiable to taxon or element (3704.4 g, or 30.7% of the total assemblage), it becomes critical to assess fragmentation as it may relate to taphonomy, to butchery and processing practices, and other bone-altering agents.

A number of variables were used to characterize fragmentation in the Gerstle River Component 3 assemblage. The variables considered include: (1) long bone breakage types, (2) number of fragments/NISP ratio, (3) NISP/MNE ratio, (4) NISP/MNI ratio, (5) ratio of complete to incomplete element portions, (6) percentage difference in articular ends (proximal and distal), (7) amount of shaft remaining on humeri, (8) percentage of articular ends relative to shaft fragments, (9) percentage of shaft weight to all long bone weight, and (10) maximum and minimum dimension measurements on the largest bone within each provenience unit. Todd and Rapson (1988) have shown that consideration of each of these variables can contribute to a more precise characterization of the taphonomy of a faunal assemblage. Some of these variables can be used to assess spatial differences in fragmentation patterns, some can be used for assessing carnivore vs. human breakage, and others can be used to address patterns of faunal trajectories through the site.

Breakage types by element (such as dry vs. green bone fractures) are difficult to observe in the Component 3 assemblage as the weatherization and the relatively poor condition of these faunal remains renders identification of green/dry breaks tenuous. However, the 46 identified appendicular long bone specimens for Component 3 were classified by primary fragmentation type (generally following Marshall 1989): complete, cylindrical (defined as oblique fracture outline only), longitudinal, transverse, and generic. Most of the bones exhibited longitudinal breakage (34.8% of total long bone specimens), but cylindrical (28.3%), generic (17.4%), and transverse (17.4%) fractures were also relatively common. Only one long bone was complete (wapiti metatarsal, 2.2% of total). When multiple codes were described per specimen (thus percentages exceed 100%), cylindrical was the most common (45.7%), with longitudinal and transverse common (39.1% an 30.4% respectively). The relatively high frequency of cylindrical fractures have been argued to imply human breakage of bone (cf. Bonnichsen 1979:69; Morlan 1980), but others argue that numerous other non-human processes could result in cylindrical or spiral fractures of fresh bone (Lyman 1994a:324), including carnivore destruction (Binford 1981) and trampling (Haynes 1983).

In order to compare how bison and wapiti differ in fragmentation patterning and element representation, I compared the number of fragments/NISP, NISP/MNE and NISP/MNI ratios for each taxon. Number of fragments/NISP and NISP/MNE ratios are 4.9 and 1.1 for wapiti, 3.2 and 1.1 for bison, and 3.9 and 1.4 for combined artiodactyls respectively, suggesting that the fragmentation of identifiable specimens was relatively similar for wapiti and bison. NISP/MNI ratios are 14.6 for wapiti, 11.0 for bison, and 23.9 for combined artiodactyls, indicating that bison remains are less well represented by the recovered identified specimens. Possible explanations include the following: (1) relatively more bison element portions were removed from the site, (2) relatively fewer bison element portions were brought into the site, (3) bison remains were more fragmented and subsequently less identifiable, or (4) concentrations of bison lie within unexcavated areas of the component. Given the similarities in identifiable elements between wapiti and bison, it is suggested that the third explanation is not correct. The fourth explanation cannot be tested without further excavation. The hypotheses that more bison element portions were removed from the site or fewer were introduced cannot be refuted at this stage. Fragmentation ratios per skeletal unit type showed little difference among taxa, with NISP/MNE ranging from 1.00-1.38, though axial NISP/MNE for unknown artiodactyls was somewhat higher, at 2.10.

Only 28 specimens (excluding teeth) are complete or nearly complete (24% of all artiodactyl NISP, n=119), including 11 carpals, 9 tarsals, 7 phalanges, and one metatarsal. Bison and wapiti had similar percentages of complete specimens across all elements. In addition, several vertebrae could also be considered complete, though only the centra and some articular processes are generally intact, the spinous, transverse, and many articular processes are generally broken, poorly preserved, or absent. This pattern is similar to that discovered by archaeologists in Paleoindian contexts (Todd and Rapson 1988; Frison 1974; Stanford 1984), though the Gerstle River Component 3 assemblage should be considered more fragmented than those discussed in Todd and Rapson (1988), as there was only one long complete long bone element present. However, percentage difference in articular ends must be assessed in order to identify differential destruction or removal of certain element portions.

Tables 6.4 and 6.5 show that generally more proximal element portions were removed or destroyed, whereas more distal element portions are better represented in the Gerstle River assemblage. For all artiodactyls, most long bones exhibited this tendency within each element, including humerus (proximal:distal MNE=0:3), metacarpal (proximal:distal MNE=3:5), femur (proximal:distal MNE=1:2), tibia (proximal:distal MNE=0:3), and metatarsal (proximal:distal MNE=5:6). Only the radius showed an opposite trend (proximal:distal MNE=4:2). These data show that proximal element portions of appendicular long bones were differentially destroyed and/or removed from the Gerstle River Component 3 assemblage.

Figure 6.29 and 6.30 show long bone fragmentation data from several Paleoindian and Late Prehistoric bone-bed assemblages (presented in Todd and Rapson 1988 and Brink 2001), wolf kill data from Binford (1981:table 4.07), and Gerstle River Component 3 assemblage of all artiodactyls. Olsen-Chubbuck is most dissimilar in having both distal and proximal ends of each bone represented, which may reflect limited carnivore destruction at that locality (Frison 1974). Of these assemblages, Gerstle River Component 3 data are most similar to Bugas-Holding (bison sample), with relatively high percent differences in humeri, metacarpals and femora, distinct from the lower percent differences of the bison bone-beds. Todd and Rapson (1988:309-313) infer bison and mountain sheep long bone fragmentation for the purpose of marrow extraction and crushing of epiphyses for bone grease extraction on the basis of limited carnivore damage, high frequency of human modifications (cut-marks and impact points), and the highly fragmented nature of the assemblage. They note that breakage of humeri near the thick-walled distal epiphysis could denote human-caused destruction rather than carnivore-caused destruction, which led to more of the shaft remaining with the distal epiphysis (Todd and Rapson 1988:314-319). This pattern is observed in the Gerstle River Component 3 assemblage, where the distal humeri (n=3) were fractured near the distal epiphysis (Figure 6.31). The cylindrical fractures exhibited in the specimens in Figure 6.31 are typical for long bones within the assemblage, and illustrate the absence of crenelated or scalloped edges suggestive of carnivore gnawing.

Figure 6.32 illustrates the %difference in articular ends among Gerstle River Component 3 (all artiodactyls), Wardell kill site, and Wardell camp site long bones. Clearly, the Gerstle River Component 3 assemblage is more closely similar to the Wardell camp site with high %differences in humeri, radius, femur, and tibia and low percent differences in metacarpals and metatarsals. There are differences, in that radii and femora are less fragmented in the Gerstle River assemblage, however the total MNE for femora is very low (MNE=1 proximal femur, 2 distal femora).

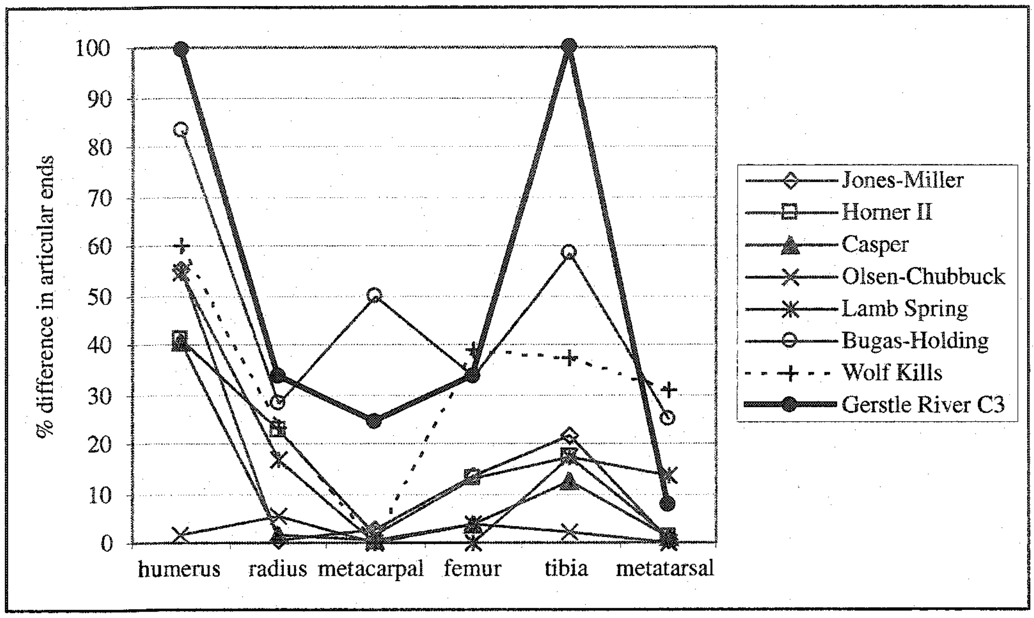


Figure 6.29 Percent differences in articular end survival in several faunal assemblages, data from Todd and Rapson (1988:Table 2), original data from Todd 1987a, 1987b; McCartney 1984; Frison 1974; Wheat 1972; and Binford 1981).

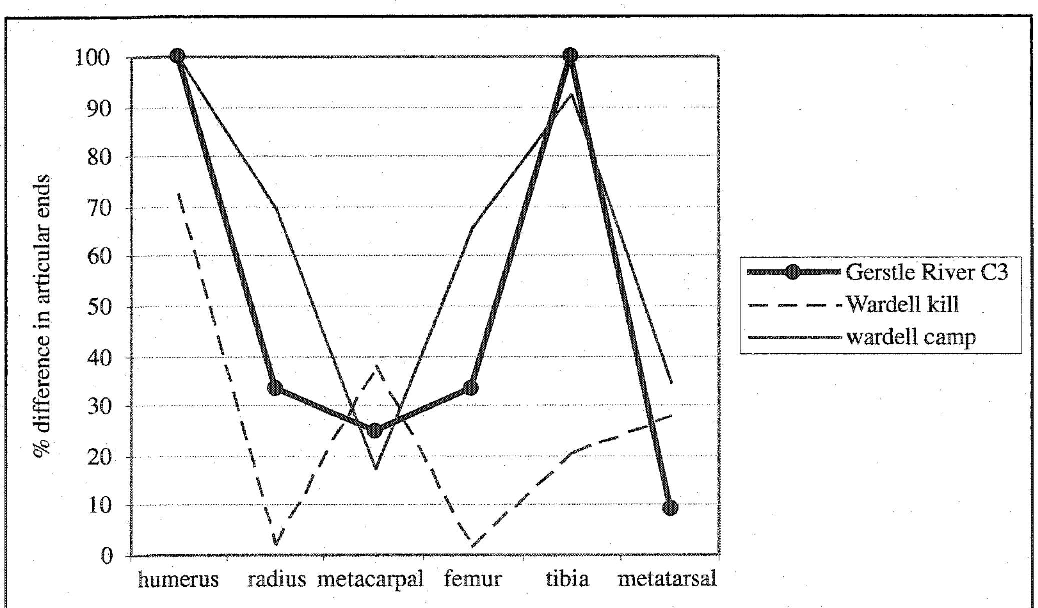


Figure 6.30 Percent differences in articular end survival in Wardell Kill site, Wardell Camp site, and Gerstle River C3 (all artiodactyl) assemblages (Wardell data from Brink 2001).

Figure 6.31 All Component 3 distal humeri (cranial view), right to left, UA2001-71-603, wapiti, UA2001-71-1035, wapiti, UA2001-71-1121, bison (with attached fragment). Note cylindrical fractures and absence of carnivore gnawing.

Another measure of fragmentation is the percentage of articular ends relative to shaft fragments (Binford 1981:175-177). Within the Component 3 assemblage, long bone ends are represented by 92 fragments and 3858.8 g (59% of total long bones) and long bone shafts are represented by 328 fragments and 2637.6 g (41% of total long bones). Total NISP shafts (excluding ribs) is 8, total NISP ends is 38. Additionally, 3 and 13 specimens have been tentatively identified as upper limb bones (femur, humerus, radius, ulna, or tibia) and lower limb bones (metapodials) respectively on the basis of shaft curvature, length, thickness, and morphology. With the addition of these specimens, total NISP shafts is 24. The ratio of ends to shafts based on weight is 1.46, and the NISP ratio of ends to shafts is 4.75 or 1.58 depending on the addition of the specimens with tentative identifications (see above).

Appendicular long bones were coded for estimated percentage of shaft, and codes included: epiphysis (E), epiphyisis + <50% of shaft (E<50%), epiphysis + >50% of shaft (E>50%), shaft (S), and complete (C). For all elements, 43% consisted of E>50%, 20% were E<50%, 17% were E or shaft, and 2% were complete. In order to document similarities and differences in breakage patterns for each element, I examined estimated percentage of shaft for each element and upper and lower limb elements (Table 6.8). Lower limb elements (metacarpals and metatarsals) were generally similar in fragmentation, with no shaft only fragments and high values of E>50%, suggesting more limited fragmentation. Upper limb elements were more varied in their fragmentation patterns. Radii-ulna were similar to lower limbs in high E>50% values. Humeri, femora, and especially tibiae were more commonly found as shaft fragments, and the lack of epiphyses (except femora) suggests higher fragmentation for these bones than for lower limb bones and radii-ulnae.

Table 6.8 Percentages of appendicular long bone estimated percentage of shaft.

Element	*NISP*	*E only*	*E<50%*	*E>50%*	*Shaft only*	*Complete*
Upper Limb	24	21	17	29	33	0
Humerus	4	0	25	50	25	0
Radius	6	33	33	33	0	0
Ulna	2	0	0	100	0	0
Femur	4	75	0	0	25	0
Tibia	8	0	13	13	75	0
Lower Limb	22*	14	23	59	0	5
Metacarpal	9	22	22	56	0	0
Metatarsal	11	0	27	64	0	9
TOTAL	46	17	20	43	17	2

* includes 2 metapodial specimens

Shaft weight (as a percentage of all long bones) varies among faunal clusters (26-82%). Three groups are apparent: one with values between 23-34% (F1, F3, F4, F9, F5), one with values of 58-63% (F2, F7), and one with values of 82% (F6). Faunal clusters F2 and F7 are interpreted as disposal areas based on a variety of data sets (see above), and the relatively high shaft weight percentages supports the higher fragmentation of long bones within these areas. The faunal clusters associated with hearths and lithic concentrations have generally low shaft weight percentages, suggesting activities resulting in lesser degrees of fragmentation, like cracking long bones for marrow extraction. The very low shaft weight percentage found at F5 further supports the contention that this area was a staging area where anatomical portions were brought to the site and stripped of meat. The low fragmentation value here suggests that marrow extraction or more intensive processing did not occur in this area. The highest shaft percentages were found in cluster F6a and F6b (both with 82%). This highlights differences in the processing that occurred in this area relative to the other processing areas. The activities that occurred in this area resulted in a relatively higher degree of long bone fragmentation than other processing areas (F1, F3, F4, and F9).

For each provenience unit, the largest fragment was measured along its maximum and minimum dimensions in order to provide a relational estimation of fragmentation (see above). Scatterplots of maximum and minimum dimensions for these provenience units for each faunal cluster are illustrated in Figure 6.32. Table 6.9 lists averages and standard deviations of these measurements for the provenience units within each faunal cluster. The presence of numerous very small fragments (less than 3 cm by 1 cm) skews the averages to lower values, however the patterning evident among the clusters is still evident. Faunal clusters associated with lithic concentrations and features generally have numerous small and fewer large faunal fragments than where fauna clusters alone, and the average maximum and minimum dimensions reflect this pattern. Clusters F2, F5, and F8 are clearly different in their relatively larger amounts of large bone fragments (>5 cm by 2 cm). The two clusters interpreted as disposal areas (F2 and F7) have generally larger fragments (and fragments are more dispersed) than their neighboring faunal clusters (F3 and F4 respectively), suggesting occupants tossed larger fragments away from the source processing areas. F8 could be considered a disposal area, and perhaps a continuation of F7.

Table 6.9 Maximum and minimum dimensions per provenience unit by faunal cluster.

Faunal cluster	*Maximum dimension (cm)*	*Minimum dimension (cm)*
Clusters associated with lithic concentrations and features		
F1	5.7±6.1	1.0±1.2
F3	3.5±4.7	0.6±0.8
F4	3.8±4.5	0.7±0.9
F6b	2.5±3.3	0.5±0.6
F9	4.4±5.3	0.9±1.0
Clusters not associated with lithic concentrations and features		
F2	8.5±3.8	1.8±1.9
F5	5.9±7.1	1.4±1.8
F6a	5.4±6.6	0.8±1.2
F7	4.9±4.9	1.1±1.1
F8	6.7±2.2	4.0±2.1
TOTAL	4.5±5.5	0.9±1.2

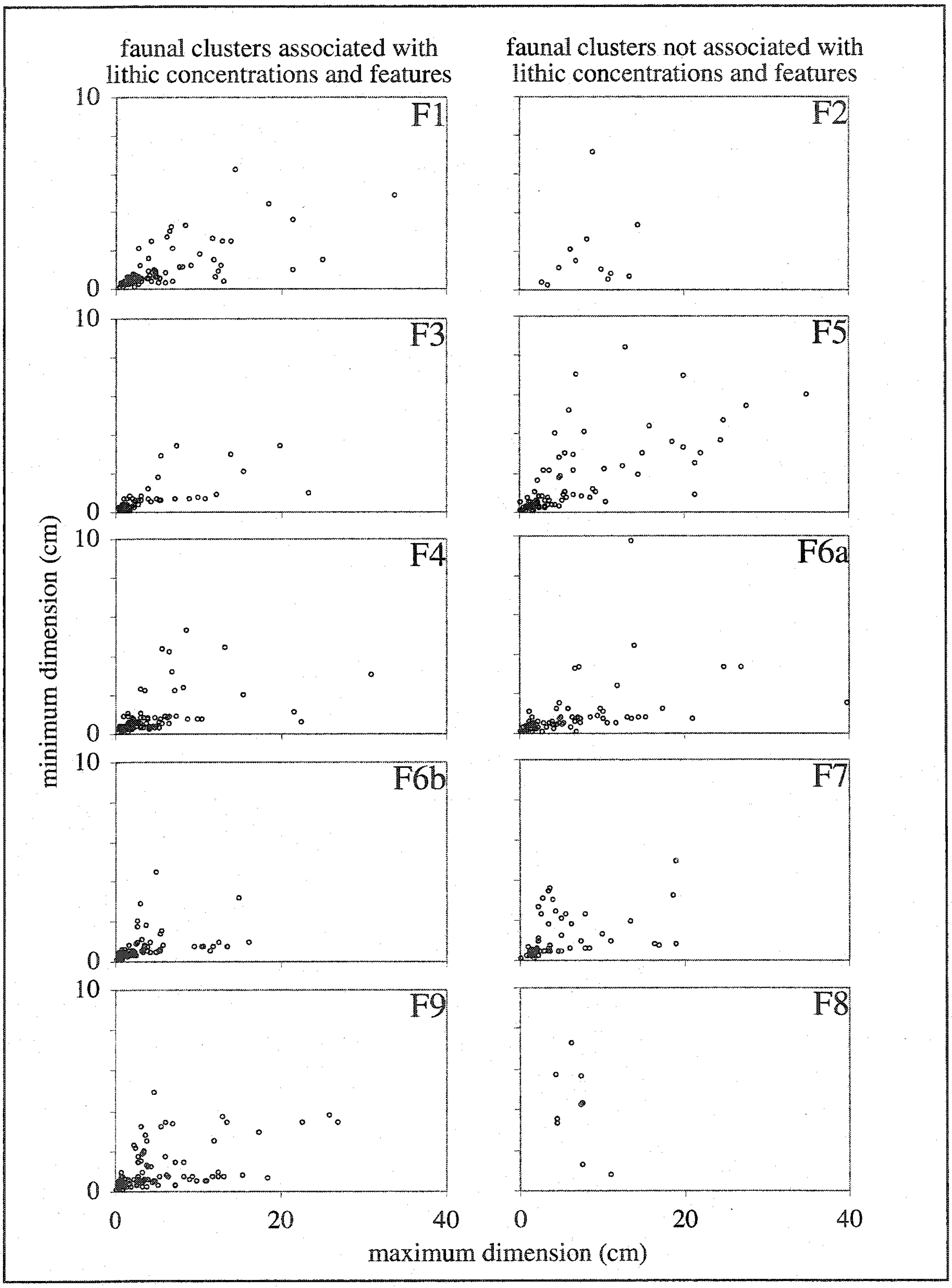


Figure 6.32 Maximum and minimum dimension scatterplots by faunal cluster.

Articulation and Refitting

The degree to which skeletal elements or element portions are articulated can be used to address intensity and type of processing that occurred in a human-modified faunal assemblage. Refitting can be used to augment spatial analysis of contemporaneous areas and to address faunal processing trajectories. Both articulation and refitting can address degree and type of fragmentation within the assemblage. Two types of articulation were distinguished for this analysis, *articulated type 1*, where element portions are 0-5 cm apart in their natural anatomical positions, and *articulated type 2*, where anatomically adjacent element portions (by species, element, and side) are 5-50 cm apart or not oriented in their natural anatomical positions. Any anatomically adjacent faunal remains located greater than 50 cm apart are considered *unarticulated*. A total of 48 NISP were considered articulated (25% of total NISP), with articulated type 1 NISP=39 (20%) and articulated type 2 NISP=9 (5%). Table 6.10 lists the articulation summaries by %NISP, %NISP weight and %total weight per faunal cluster.

Table 6.10 Articulation summary by faunal cluster.

Faunal cluster	*Articulated NISP*	*Articulated %NISP*	*Articulated NISP wt.*	*Articulated %NISP wt.*	*Articulated %total wt.*
F1	2	12	214.7	15	10
F2	0	0	0.0	0	0
F3	5	15	213.6	41	33
F4	4	27	102.3	12	8
F5	18	40	1040.0	40	37
F6a	2	10	100.5	17	8
F6b	0	0	0.0	0	0
F7	0	0	0.0	0	0
F8	6	67	199.9	77	10
F9	11	44	180.0	14	17

Relatively few faunal remains are articulated in the Component 3 faunal assemblage (17% of total weight). Of the faunal remains that are articulated, only compact bones (carpals, tarsals, and phalanges) are complete or nearly complete; the remaining bones are fragmented in various ways (see above) but retain their articulation or close proximity to anatomically adjacent bones. Articulation is patterned across the site, with some faunal clusters exhibiting relatively high levels of articulation and others with low levels. Most clusters contain only a few articulating element portions. Faunal cluster 1 contains L and R mandibles (NISP=2). Faunal cluster 3 contains articulated lumbar vertebrae (NISP=5). Faunal cluster 4 contains L 2nd and 3rd carpal, metacarpal, and unciform (NISP=4). Faunal cluster 6a contains L tibia and L astragalus (NISP=2). Faunal cluster 8 contains R and L 1st, 2nd, and 3rd phalanges (NISP=6). Three faunal clusters contain no articulating specimens (clusters F2, F6b, and F7). Two faunal clusters exhibit higher numbers of articulating specimens (F5 and F9). Faunal cluster 5 contains two articulating lumbar vertebrae columns (combined NISP=11), 1st, 2nd, and 3rd phalanges (NISP=3), and two R radii and ulnae (NISP=4). Faunal cluster 9 contains R metatarsal, R external cuneiform, and R naviculo-cuboid (NISP=4), L 2nd and 3rd carpal, cuneiform, lunar, scaphoid, and unciform (NISP=5), and R 2nd and 3rd carpal and scaphoid (NISP=2).

Most faunal refits are located very close to each other (within 20 cm) with the exception of UA2000-54-289 and UA2003-54-1055 and 1056 (R metatarsal), which are located about 12 meters apart (cluster F4 and F9). This linkage between Areas B and D also occurs with lithic refits, where core tablets refit between EU N48E45 and N44E50 (UA99-62-11 and UA2001-71-1591). Only three large cranial fragments were found within the Component 3 assemblage, UA2001-71-646, -647, and UA2002-62-563, the first two are almost certainly two portions of a split cranium including both R and L maxilla portions, and the last is a occipital cranial fragment. All three specimens are wapiti, and it is conceivable that they are from the same individual, as the maxillae are located about 2 m from the occipital fragment.

The limited articulation and the nature of this articulation and refitting supports the hypothesis that the animals were killed and butchered offsite (perhaps nearby, given high relative numbers of low meat yield elements). The butchering that occurred at the kill-site (or otherwise off-site) probably consisted of hide stripping, dismemberment of limbs and head, and possibly other anatomical units. These anatomical units were then transported to the Gerstle River site where further processing occurred, including marrow extraction from long bones (but not from compact bones like tarsals, carpals, and phalanges).

Skeletal Part Frequency Analysis

Relationships among the skeletal parts actually found at Gerstle River Component 3, those expected to be found assuming whole carcasses were brought to the site, and those expected given MNE and MNI calculation are important in understanding processing decisions made by site occupants. The underlying data that must be addressed includes the skeletal parts actually present at the site per taxon. The processes that led to the assemblage composition include transport or destruction decisions made by site occupants, carnivore scavenging, rodent scavenging, differential taphonomic destruction (e.g., crushing by overburden, *in situ* weathering) and other density-mediated attritional processes. Differentiating the relative importance of these processes, which often have problems of equifinality, will require analysis of two interrelated types of data: bone density/%survivorship and utility indices. Element deletion is discussed to set the stage for examining the relative contributions of bone density and bone utility to the faunal assemblage

The %MAU values for the Component 3 assemblage are illustrated in Figures 6.3, 6.4, and 6.5. The most common bison element portions include distal metacarpals, calcaneus, and proximal and distal metacarpals. The most common wapiti element portions include maxilla, mandibles, proximal radius, distal metatarsal, proximal metacarpal, and proximal metatarsal. The most common element portions for combined artiodactyls was maxilla, distal metatarsal, lumbar vertebrae 1-5, mandible, proximal metatarsal, distal metacarpal, scapula, proximal radius, calcaneus, sacrum, innominate, and tibial crest. The differences in %MAU between bison and wapiti are shown in Figure 6.6 and discussed above.

Key behavioral transport and processing issues in skeletal part frequency analysis below include (1) what anatomical units brought to the site, (2) what happened to these units while they were at the site, and (3) what units were taken away from the site.

Element Deletion

A number of skeletal parts are absent in the Component 3 faunal assemblage. For bison, missing parts include cranium, maxilla, hyoid, atlas, axis, cervical vertebrae, thoracic vertebrae, caudal vertebrae, sternabra, costal cartilage, rib, proximal humerus, radius-ulna, proximal metacarpal, distal femur, tibia, patella, tarsals, and sesamoids. For wapiti, missing parts include hyoid, atlas, axis, cervical vertebrae, thoracic vertebrae, caudal vertebrae, sternabra, costal cartilage, rib, scapula, proximal humerus, proximal femur, patella, and sesamoids. For all artiodactyls, missing parts include hyoid, axis, thoracic vertebrae, caudal vertebrae, sternabra, costal cartiglage, 5th metacarpal, patella, and sesamoids. In addition to the absent skeletal parts, a number of parts with very low %MAU values ($\leq$10) include carpals for bison, 2nd and 3rd phalanx for wapiti, and cervical vertebrae and rib for all artiodactyls.

Aside from mandible/maxilla/teeth specimens, the relative proportions of skeletal unit types are even for bison and wapiti: lower limbs 42-45% of total weight per taxon, upper limbs 26-27%, and axial elements 15-28% (Figures 6.33). The relatively higher percentages of unknown large artiodactyl upper limb element portions (49% of unknown artiodactyl weight) likely result from the higher degree of fragmentation of these element portions. When all artiodactyl specimens are combined, the percentages of skeletal units (by weight) are axial 23%, maxilla/mandible/teeth 10% (total axial, 33%), upper limb 30%, and lower limb 37%, showing the disparity in identification due to higher fragmentation of upper limb bones. Dry bone weight averages for four complete caribou and bison (Binford 1978a; Emerson 1990:295-296) are compared with Gerstle River specimens in Figure 6.33. Clearly axial portions are under-represented and limb portions are over-represented, especially for lower limbs, when compared to complete ungulate dry bone weights.

Depressed axial values are evident for Gerstle River Component 3 wapiti and bison relative to complete bison and caribou values (from Emerson 1990 and Binford 1978a) (see Figure 6.34). Bison, wapiti, and combined artiodactyl values for axial elements are around 30% of total skeletal weight, whereas Binford's adult caribou and sheep yielded values of 73-74% of total dry bone weight (Binford 1978a:15-17). However, bison axial relative values are somewhat lower (57% of total) given more robust appendicular elements (Figure 6.34). Nevertheless, the Gerstle River Component 3 percentages are roughly 24-29% depressed relative to complete bison. Much of this is due to the absence of cervical and thoracic vertebrae and ribs.

The food resources associated with ribs and thoracic vertebrae could be absent due to a number of scenarios, and only those related to human behavior are described here. These anatomical portions could have been (1) removed from the animal at the kill site (off-site) and processed/eaten there; (2) brought to the site and processed there, and removed from the site to a base camp or other camp elsewhere; (3) differentially destroyed through processing on site. The relative lack of upper limb bones may be due to (1) removal from animal at kill site, meat stripped, and elements discarded at the kill site, or (2) elements were introduced into the site and differentially destroyed through marrow extraction processing. These scenarios are considered below.

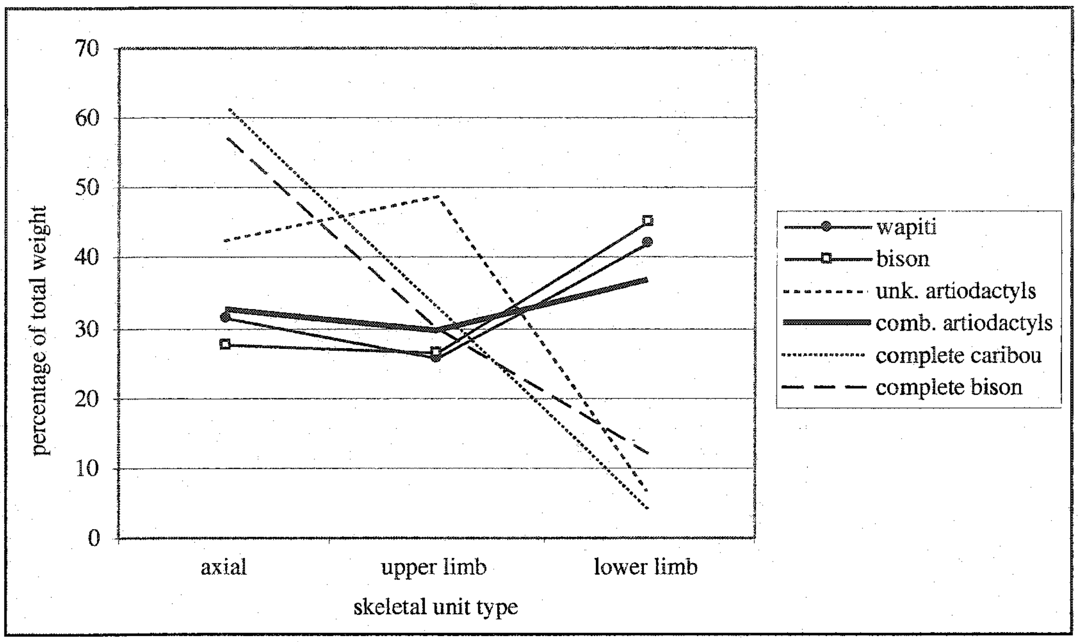


Figure 6.33 Skeletal unit type percentages by total weight per taxon and for complete caribou and bison dry bone weight (from Binford 1978; Emerson 1990:295-296). Note that axial and teeth categories are combined for this graph.

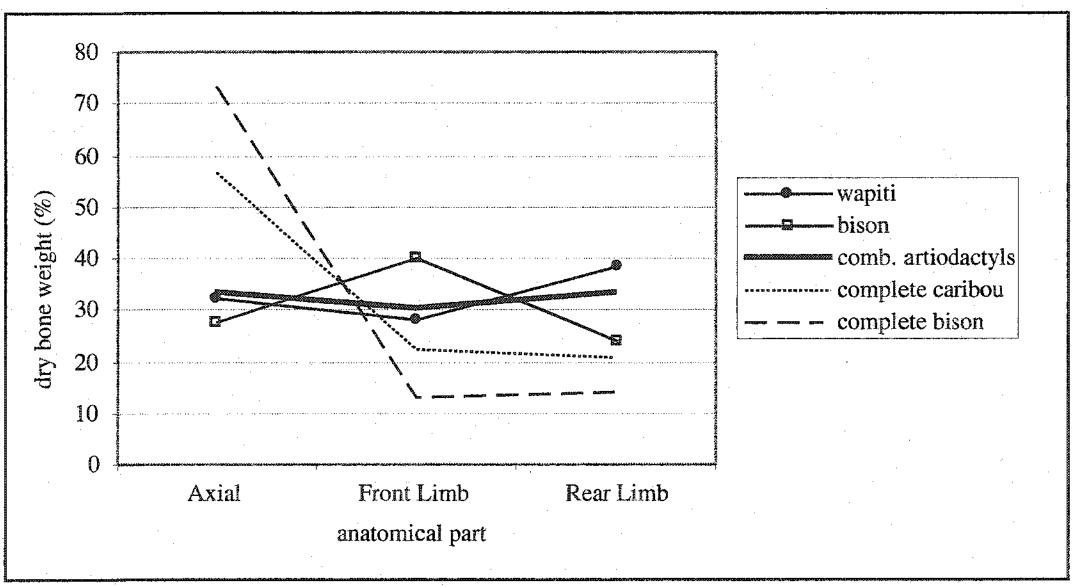


Figure 6.34 Dry bone weight percent by anatomical part for Gerstle River artiodactyls, adult male caribou (Binford 1978:15-17), and average of four adult bison (Emerson 1990:295-296).

Three potential causes of spatial patterning of faunal remains may have occurred on site. Certain areas may have been established for certain processing tasks such as butchery (removal of meat from the carcass) or marrow extraction. Each hearth area could have been the locus of a larger range of processing tasks (e.g., butchery, cooking, and marrow processing at each hearth area). Finally, all processing tasks could have occurred at one area and other processes moved the elements around. Of these three possibilities, the first hypothesis is consistent with the spatial patterning given the spatial analysis above, however marrow processing does appear to be correlated to a number of hearth areas.

In sum, the absence of various skeletal elements and element portions from the Gerstle River Component 3 assemblage could result from a number of reasons, a common problem of equifinality. Various density-mediated attritional processes are discounted as major taphonomic agents on the basis of bone density and %survivorship analysis presented below. Two remaining hypotheses are (1) differential introduction of elements to the site, and (2) differential removal/destruction of elements on-site. Both hypotheses are examined below.

Bone Density and %survivorship

A number of archaeologists (Grayson 1989; Lyman 1985, 1992; Marean and Frey 1997; Marean and Cleghorn 2003) noted that reverse utility curves could result not just from differential bone transport, but from density-mediated destruction, which could be due to carnivore destruction, *in situ* weathering, or other taphonomic agent. To evaluate the potential for density-mediated attrition of the Component 3 faunal assemblage taxa, I plotted the %survivorship, following Lyman (1994a:239-245), against bone mineral densities (g/cm^3) for 100 bison skeletal parts derived from Kreutzer (1992). Kreutzer (1992) used photon absorptiometry (PA) to derive bone mineral densities for portions of skeletal elements (see Lam et al. 2003 for criticisms of PA). Given the lack of obvious carnivore damage on these specimens, the major density-mediated attritional factors would include human removal of low density anatomical parts and differential fragmentation of less dense bones through human or natural agencies. The results are illustrated as scatterplots (Figure 6.35). The Spearman's rho correlation coefficient of rank order (r_s) between density and bison %survivorship is weakly positive and not significant (r_s=0.11, p=0.292). Wapiti %survivorship has a slightly stronger (but still weak) positive relationship with density (r_s=0.32, p=0.001). Combined artiodactyl %survivorship has a weak positive relationship with density (r_s=0.29, p=0.004).

These results indicate that density-mediated attritional/taphonomic processes probably did not play a major role in the formation of the Component 3 faunal assemblages. The weak positive correlation of wapiti %survivorship and bone density may be the result of disintegration of cancellous (or trabecular) bone through surface and *in situ* weathering or the weight of overlying sediments. Lyman (1994a:261) notes that post-depositional destruction is an important component in bone loss in archaeological sites. Bones with low mineral density, such as lumbar vertebrae, distal femora, and scapulae have %MAU values of 85.71, 28.57, and 57.14 respectively (comb. artiodactyls). The presence of low density bone portions suggests that the expected element portions based on MNI but not found at the site were not likely removed due to disintegration through *in situ* weathering or other density-mediated attrition.

Lyman et al. (1992) note that different patterns of fragmentation can influence correlation of %survivorship and bone density. At the Gerstle River Component 3 assemblage, certain elements (upper limb bones, flat bones, vertebra) appear to be in a more fragmented state (see above), thus reducing the potential to recognize and identify to taxon. Almost 41% of the long bone fragments recovered in Component 3 are shaft fragments, and unidentified long bone fragments constitute 35% of all long bones by weight. These percentages suggest that a number of long bone shaft portions have not been identified due to extensive fragmentation and removal of diagnostic landmarks.

Marean and Frey (1997) have proposed that reverse utility curves generally found in archaeololgical faunal assemblages may be the result of (1) lumping long bones with non-long bones in the same %survivorship or %MAU/density scatterplots, and/or (2) estimating long bone values from articular ends and not from shafts (1997:702, 709). To assess this possibility, I plotted %survivorship against mineral bone density (Kreutzer 1992) for long bones (35 scan sites) and non-long bones (65 scan sites) in Figure 6.35. Long bones consistently exhibit a moderate positive correlation with bone density (for bison, r_s=0.32, p=0.063, for wapiti, r_s=0.51, p=0.002, for combined artiodactyls, r_s=0.573, p=0.000), whereas non-long bones show no correlation with density (for bison, r_s=-0.00, p=0.980, for wapiti, r_s=0.22, p=0.065, for combined artiodactyls, r_s=0.17, p=0.163). This difference is somewhat difficult to explain. Since non-long bone survivorship may be density-dependent (Lyman 1985, 1992; Grayson 1989), Marean and Frey (1997:708) suggest that "it is likely that zooarchaeologists will be unable to accurately estimate

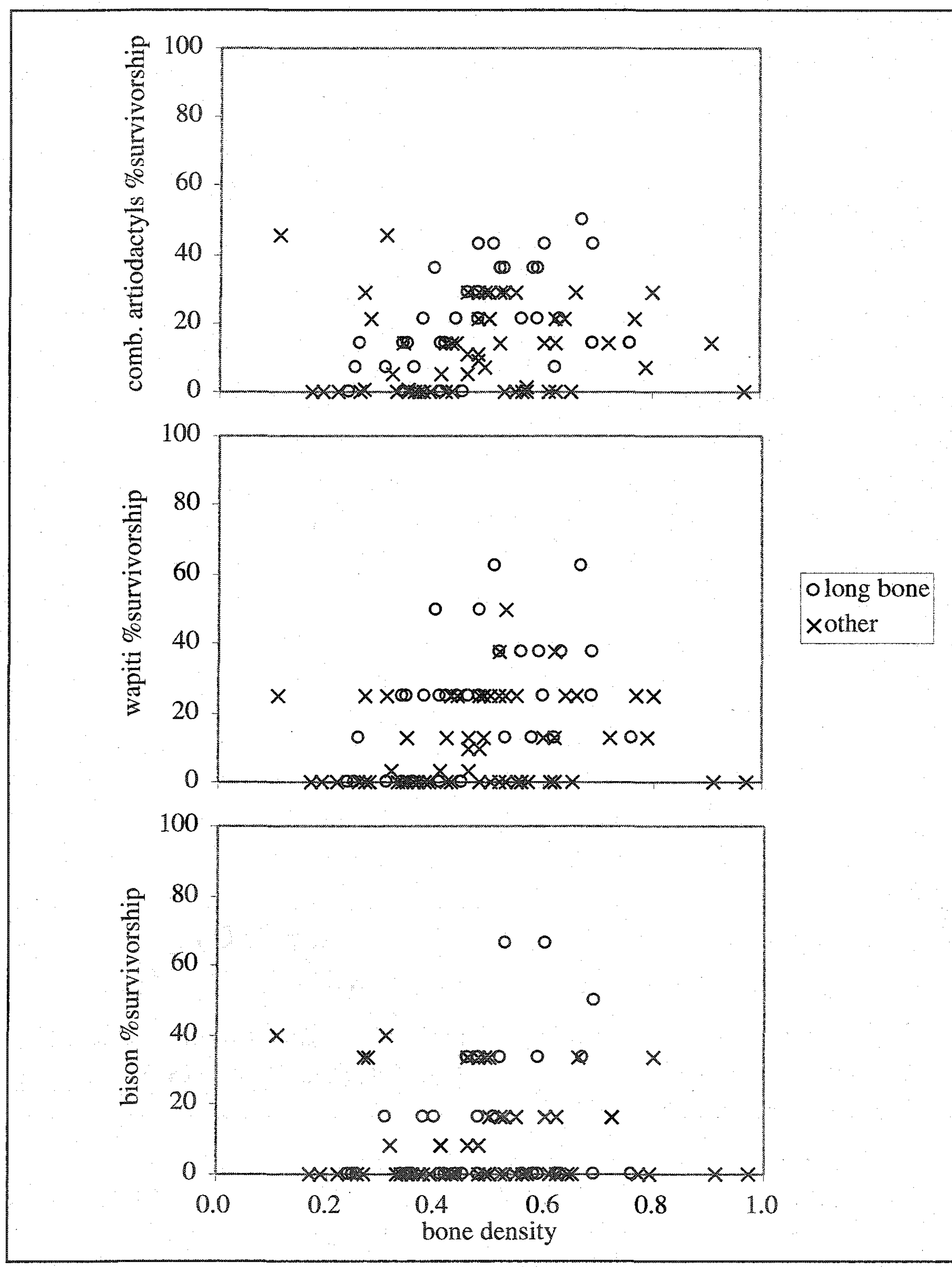


Figure 6.35 %survivorship of bison, wapiti, and combined artiodactyl skeletal parts against bone mineral density for bison (Kreutzer 1992).

the original or relative abundance of non-long bone postcrania in archaeological assemblages." However, since the Gerstle River Component 3 assemblage non-long bones have similar %MAU values as long bones, and MNIs based on long bone and non-long bone MNEs are similar, it is argued here that significant numbers of non-long bones are not absent due to density mediated processes. The positive correlation between %survivorship and bone density for long bones may result from differential transport of some long bone ends or differential destruction on-site.

Carnivore scavengers generally destroy spongy, greasy bones, such as vertebrae, innominates, ribs, scapulae, and the epiphyses of long bones (Brain 1981; Blumenschine 1988; Marean and Spencer 1991; Marean and Frey 1997). The Gerstle River Component 3 assemblage do not show depressed MAU or %MAU values for these element portions, except for ribs (see Tables 6.4 and 6.5). This pattern suggests that carnivore scavenging did not play an important role in element deletion or destruction at Gerstle River Component 3.

Bone density measures were also used to test between density-mediated attrition and human-related differential transport or destruction of faunal elements. Grayson (1988:70-71, 1989:647) suggested that assemblages exhibiting density-mediated attrition would show a significant positive correlation between %MAU and bone density, whereas assemblages exhibiting differential transport would show a significant positive correlation between %MAU and a utility measure (%MGUI or (S)FUI) and an insignificant correlation between %MAU and bone density (see also Lyman 1994a:258-281). A third category can be posited, that of an assemblage from which elements were differentially transported to another location, and which should show a significant negative correlation between %MAU and %MGUI and an insignificant correlation between %MAU and bone density. Following Rapson (1990) and Lyman (1994a), I have used the maximum density values for each MAU skeletal category defined in Lyman (1994a:Table 7.10) to allow for correlation analysis. A total of 26 element portions were used to compare %MAU and (S)FUI, and 25 element portions were used to construct %MAU and bone density. Bone density of the sternum was not examined by Kreutzer (1992).

Using Metcalfe and Jones (1988) food utility index [(S)FUI] for caribou and Kreutzer's (1992) bone density estimates for bison, Figure 6.36 compares %MAU with bone density and (S)FUI. A negative correlation between %MAU and (S)FUI is apparent (r_s=-0.35, p=0.087), whereas there is no correlation between %MAU and bone density (rs=0.09, p=0.691). Other food-related indices suggest a negative correlation between element abundance and food utility (see Table 6.11 below), especially with the relative lack of cervical vertebrae, thoracic vertebrae,

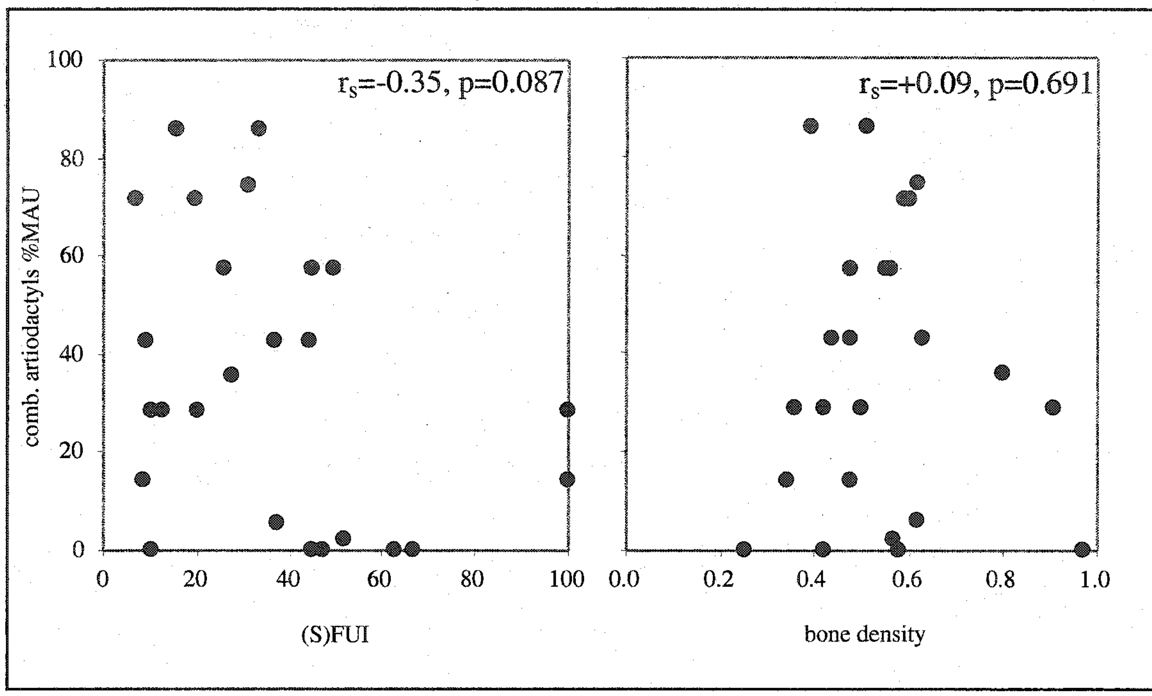


Figure 6.36 Combined artiodactyls %MAU against (S)FUI (Metcalfe and Jones 1988) and bone density (Kreutzer 1992).

ribs, femora, humeri, and proximal tibiae. This patterning places the Gerstle River Component 3 assemblage within Lyman's Class 2 (reverse utility, not winnowed or lagged/ravaged) (Lyman 1994a:258-263). Therefore, Gerstle River Component 3 assemblage is a good example where human differential transport or destruction of certain high yield elements (with respect to food utility) played a major taphonomic role in the formation of the faunal assemblage but density-mediated destruction did not.

Utility Indices

After considering the relative importance of various density-mediated attrition processes, we are in a better position to evaluate economic utilization of the carcasses brought to the site. Desired food products may be related to specific skeletal elements (Binford 1978a; Emerson 1990; Metcalfe and Jones 1988). Various models of economic utility have been proposed for ungulates, including models for caribou (Binford 1978a; Metcalfe and Jones 1988), bison (Emerson 1990; Brink and Dawe 1989; Brink 1997, 2001), musk-ox (Will 1985), horse (Outram and Rowley-Conwy 1998), and guanaco (Borrero 1990). The construction and use of economic utility models have been criticized (e.g., Lyman 1985; Metcalfe and Jones 1988; Grayson 1989;

Ringrose 1993, but see Pilgram and Marshall 1995). It is beyond the scope of this chapter to fully discuss these criticisms, but three are important for this analysis, the first two outlined by Brink (2001:255-257).

First, application of these economic models (especially those formulated as total products, total food utility, or general utility) to archaeological skeletal assemblages assumes that the relative abundance of element portions is directly related to the total products available. This assumption may be warranted in smaller animals like caribou and sheep, but with larger, bulkier animals like wapiti and bison, transport, butchering, and processing decisions are more complicated (Brink 2001:255-257; see also O'Connell et al. 1990 and Ringrose 1993). This is addressed through the use of multiple utility indices. Second, the association between the food products and the skeletal elements are not constant or equally close for all elements, and are dependent upon butchery strategies (Bunn et al. 1988; Bartram 1993; Kent 1993; Yellen 1977b). Brink (2001:256) suggests that long bones that are more closely linked to their resources, especially marrow and bone grease, are more suitable for analysis and more useful for explanation of archaeological assemblages. This issue is addressed through the analysis of all element portions and axial/appendicular element portions (see below). Third, the application of economic utility indices assumes that decisions about transport and processing relate solely to food-related resources, and ignores any non-food related resource (e.g., hide, hair, blood, hooves, horns, antler, tendons, and ligaments). However, given other contextual data on the Gerstle River Component 3 lithic, fauna, and worked fauna assemblages, there is little evidence for non-food related exploitation of fauna in the component. Furthermore, the purpose of this analysis is to assess which food-related resources may have affected element abundance holding other resources constant.

As Ringrose (1993:151) and others have noted, the nature relationships between economic indices and element abundance are generally not precise enough to enable detailed statistical manipulation and hypothesis testing. Therefore, Spearman's rho correlation coefficients are used in a heuristic, exploratory fashion, and alpha levels are set at 0.08 and 0.05. A specific food-based resource predictive model explaining the variability in element abundance is not the purpose of this analysis; the purpose is to examine patterning with respect to possible resource use. Therefore, following Brink, patterns among positive and negative correlations among %MAU values and various utility indices are assessed for all elements and appendicular elements, as the latter are more closely linked with specific resources, namely marrow and grease (Brink 2001; see also Ringrose 1993:147-149).

Tables 6.11 and 6.12 list the results of the correlations among utility indices (independent variables) and bison, wapiti, and combined artiodactyl %MAU (dependent variables). Significant correlations are presented as scatterplots in Figures 6.37 and 6.38. In general, wapiti and combined artiodactyl %MAU, and to a lesser extent, bison %MAU are negatively related to meat and white grease related utility indices (such as total products, protein, total food, and food utility), and positively related to marrow indices for all elements (n=26), though significance varies. Yellow grease is also positively related to bison and wapiti %MAU, though not significant for combined artiodactyls.

These results are generally replicated for various caribou indices (Binford 1978a; Metcalfe and Jones 1988), where (S)FUI, meat and MGUI are negatively correlated with artiodactyl abundance. One difference between the caribou and bison economic utility indices is related to the marrow index (Emerson's (S)MAVGMAR and Binford's Marrow Index). While the former does exhibit a very weakly positive relationship (r_s=+0.08-0.19), the latter is more strongly positive (r_s=+0.22-0.55) and is significant for wapiti and combined artiodactyls. This is due to the higher relative marrow values for metatarsals, metacarpals, and distal radii in Binford's index (all with relatively high %MAU values), though the overall correlation between the two indices is high and significant (r_s=0.67 p=0.000). A second difference is the positive relationship with Binford's White Grease index and negative relationship with Emerson's white grease index ((S)MAVGWG). Only the (S)MAVGWG-combined artiodactyl %MAU correlation is significant at the α=0.08 level (r_s=-0.46, p=0.072), suggesting that Emerson's white grease index better predicts abundance. Overall, the patterning supports the argument that marrow extraction occurred on bison and wapiti carcasses or carcass segments, and bone grease rendering was limited or nonexistent.

The most consistent relationship between economic resource type and element abundance is relatively high abundance of elements with high marrow yields and low abundance of elements with high meat and white grease yields. Such a pattern is often termed a "reverse utility curve." However, Lyman (1985), Grayson (1988, 1989) and others have observed that this common archaeological pattern may result from other processes, including differential bone transportation (by humans, other carnivores, or scavengers) and/or differential destruction. Grayson suggests that differential destruction is a more common cause than differential transport (1989:643). This

Table 6.11 Correlation (r_s) of all units (%MAU) (n=26) with various utility indices.

Utility Index	*Combined artiodactyls %MAU*	*Wapiti %MAU*	*Bison %MAU*
Bison (Emerson 1990)			
(S)MAVGTP (total products)	-0.19	-0.29	-0.13
(S)AVGMUI (utility)	-0.22	-0.35*	-0.11
(S)MAVGPRO (protein)	-0.21	-0.32	-0.12
(S)MAVGMAR (marrow)	+0.08	+0.19	+0.10
(S)MAVGWG (white grease)	-0.46*	-0.34	-0.41
(S)MAVGYG (yellow grease)	+0.44	+0.62*	+0.62*
(S)MAVGTF (total food)	-0.19	-0.26	-0.16
(S)MAVGGRE (total grease)	+0.14	+0.23	+0.11
(S)MAVGSKF (skeletal fat)	+0.15	+0.21	+0.09
(S)AVGFUI (food utility)	-0.21	-0.26	-0.13
Caribou (Metcalfe and Jones 1988)			
(S)FUI (food utility)	-0.35*	-0.38*	-0.20
Caribou (Binford 1978a)			
Meat Index	-0.19	-0.30	-0.12
Marrow Index	+0.40**	+0.51**	+0.22
White Grease Index	+0.08	+0.28	+0.07
MGUI	-0.29	-0.32	-0.08
Bison bone density (Kreutzer 1992)	+0.09	+0.09	-0.11

* significant at α=0.08 level (2-tailed)

** significant at α=0.05 level (2-tailed)

Table 6.12 Correlation (r_s) of appendicular units (%MAU) with various utility indices.

Utility Index	*Combined artiodactyls %MAU*	*Wapiti %MAU*	*Bison %MAU*
Appendicular Units (n=16)			
Bison (Emerson 1990)			
(S)MAVGTP (total products)	-0.40	-0.47*	-0.31
(S)AVGMUI (utility)	-0.39	-0.49*	-0.25
(S)MAVGPRO (protein)	-0.40	-0.47*	-0.28
(S)MAVGMAR (marrow)	-0.46*	-0.29	-0.50*
(S)MAVGWG (white grease)	-0.46*	-0.34	-0.41
(S)MAVGTF (total food)	-0.44	-0.45	-0.36
(S)MAVGGRE (total grease)	-0.49*	-0.34	-0.43
(S)MAVGSKF (skeletal fat)	-0.51**	-0.41	-0.48*
(S)AVGFUI (food utility)	-0.41	-0.38	-0.34
Caribou (Metcalfe and Jones 1988)			
(S)FUI (food utility)	-0.41	-0.47*	-0.29
Caribou (Binford 1978a)			
Meat Index	-0.23	-0.39	-0.17
Marrow Index	+0.46*	+0.50*	-0.01
(White) Grease Index	-0.34	-0.20	-0.26
MGUI (general utility)	-0.36	-0.43	-0.21
Bison bone density (Kreutzer 1992)	+0.48*	+0.42	+0.28
Limb elements (n=6)			
Marrow (Brink 2001)	-0.40	-0.62	-0.74
Limb element portions (n=12)			
Grease (Brink 2001)	-0.70**	-0.59**	-0.42

* significant at α=0.08 level (2-tailed)
** significant at α=0.05 level (2-tailed)

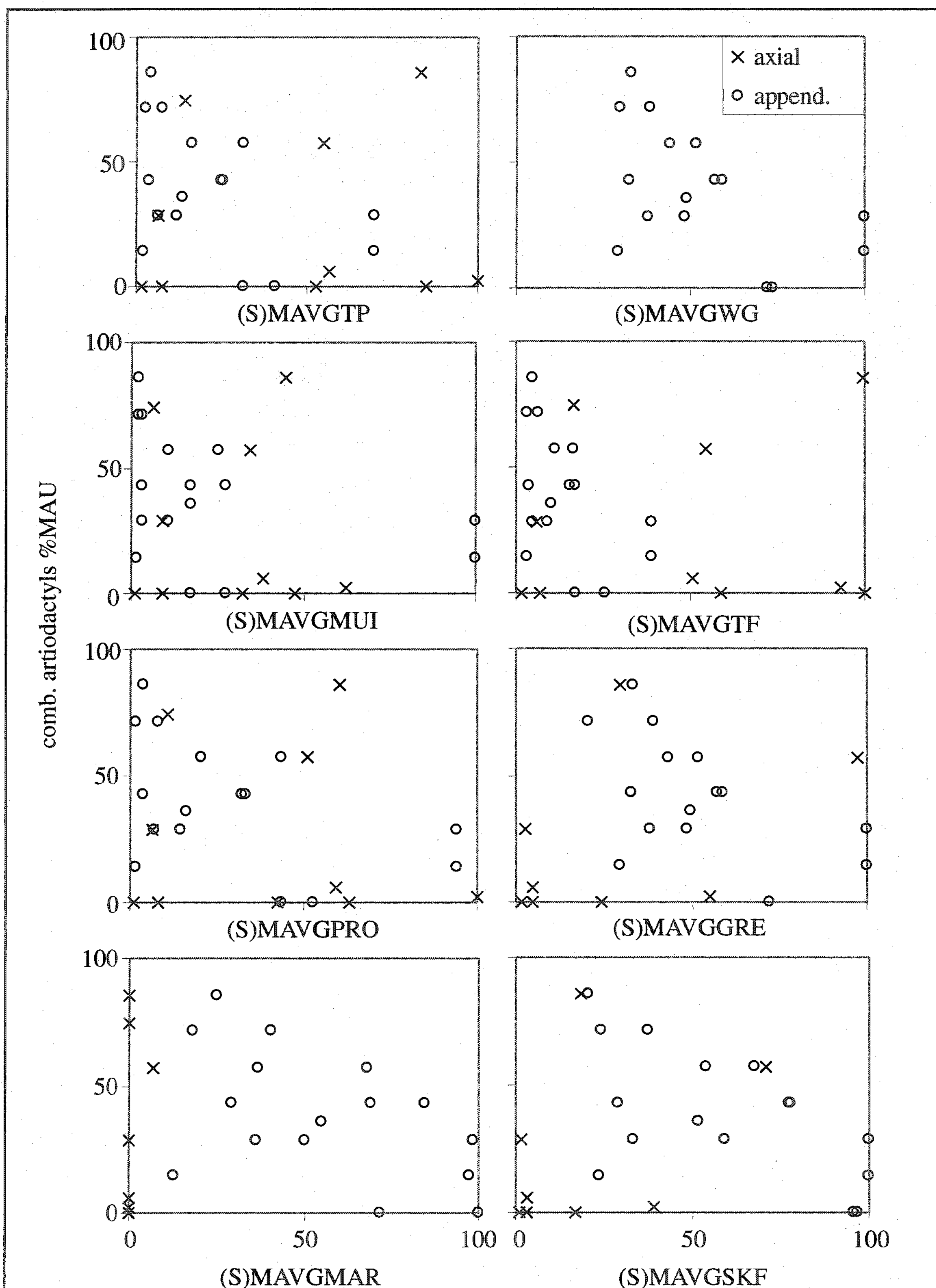


Figure 6.37 Combined artiodactyls %MAU against bison utility indices (from Emerson 1990).

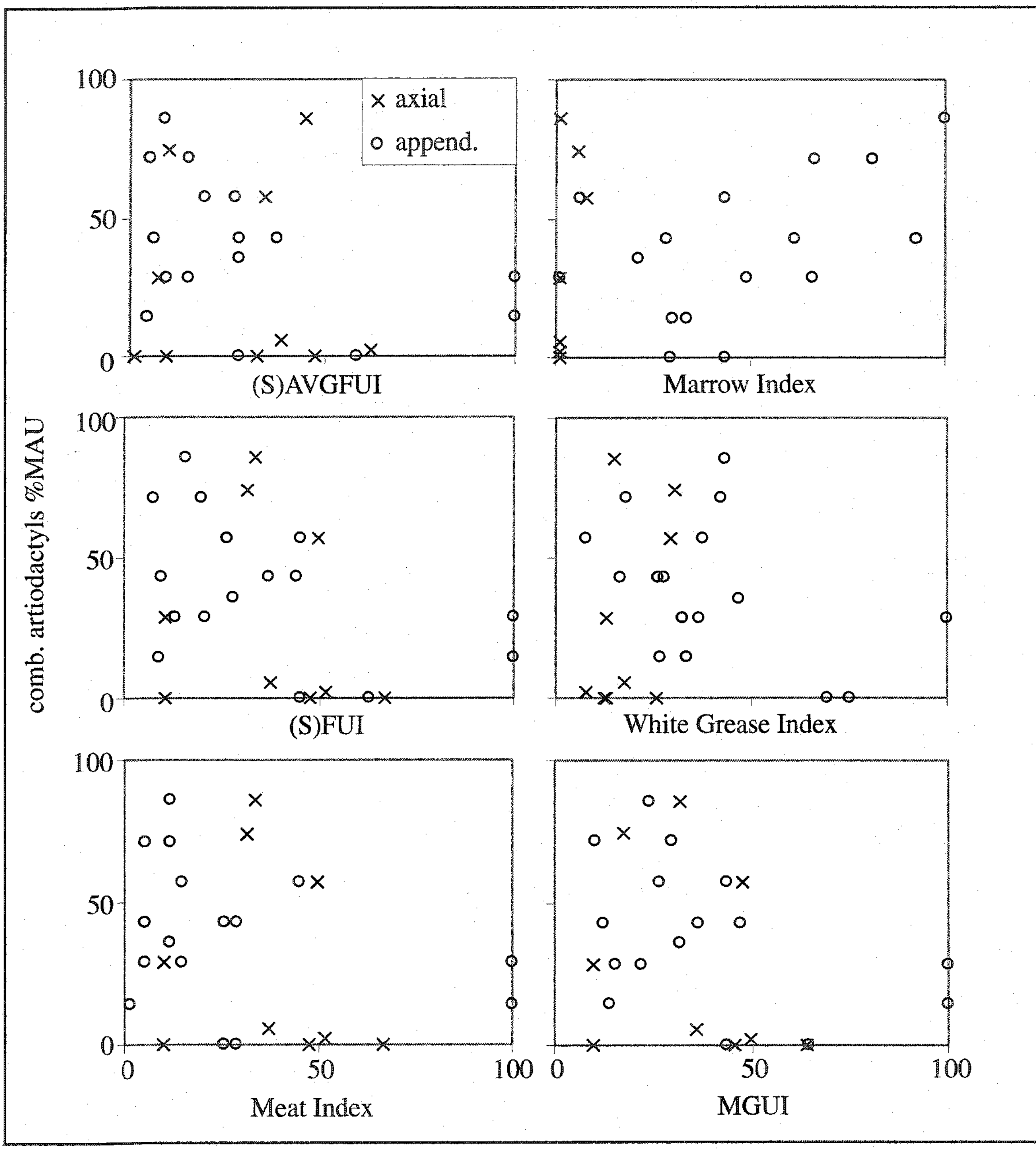


Figure 6.38 Combined artiodactyls %MAU against bison utility index (S)AVGFUI (from Emerson 1990) and caribou utility indices ((S)FUI from Metcalfe and Jones 1988; others from Binford 1978).

possibility is evaluated above and differential destruction is considered not to be a major taphonomic agent in the formation of this assemblage.

Given Marean and Frey's (1997) critique of aggregating long bones with non-long bones in assessing utility indices, long bone were analyzed separately, and the results are listed in Table 6.12. More indices are significantly correlated to long bone abundance. Emerson's (1990) total products, utility, protein, marrow, white grease, total grease, and skeletal fat are all moderately negatively correlated with artiodactyl abundance (with r_s generally –0.47 to –0.51). (S)FUI, Meat Index, White Grease Index, and MGUI for caribou are negatively correlated (but not significant), and Marrow Index is the only positive correlation found (rs=0.50, p=0.051 for wapiti, and +0.46, p=0.074 for combined artiodactyls). These results generally complement those obtained from examination of all elements, but there are some differences. In general, there are more significant correlations between long bones and utility indices than all elements (13 vs. 7). The meat and grease related indices are still negatively correlated with abundance, however, the differences in Binford's Marrow Index and Emerson's (S)MAVGMAR are accentuated. Binford's higher relative marrow values for metacarpals, metatarsals, and distal radii cause this divergence. Given the general similarities in other economic indices created for bison and caribou (Binford 1978a; Emerson 1990; Brink and Dawe 1989; Brink 1997; Brink 2001), the difference in marrow indices requires further examination of the techniques used in their construction.

Brink (2001) used marrow and grease indices to assess bison processing behaviors in the Wardell kill and camp assemblages. A negative relationship was found between %MAU and %marrow weight at the Wardell kill assemblage and a positive relationship at the Wardell camp assemblage (Brink 2001:263-264). Based on this pattern, he inferred that marrow-maximizing strategy occurred at the kill site, where elements with high marrow yields like femora, tibiae, and humeri were commonly present and broken, whereas bones broken at the camp site represent a non-maximizing marrow recovery strategy, where elements with high marrow yield like femora, tibia, and humeri were generally not present, and elements with low marrow yields like metacarpals and metatarsals were commonly present and broken. This pattern suggests that kill site processing included marrow extraction from generally only high yield elements, and camp site processing included marrow extraction from medium to low yield complete limb bones transported from the kill site (see Brink 2001:266-267). Alternatively, these lower limb elements may have been differentially transported to the camp site, perhaps due to tendons and ligaments useful as non-food related resource (Perkins and Daly 1968).

Bison marrow mean % from Brink (2001) and Gerstle River Component 3 long bone %MAU are compared in Table 6.12. The relationship is negative and insignificant ($rs=-0.40$ $p=0.440$, $n=6$), but generally similar to the Wardell camp assemblage, suggesting that the bones with the highest marrow weight were differentially destroyed or absent from the Gerstle River assemblage. Additionally, this pattern suggests similarities between the Wardell camp site and Gerstle River Component 3, inferred to be a camp rather than a kills site. This pattern is reflected in fragmentation patterns of long bones. Figure 6.29 illustrates the %difference in articular ends among Gerstle River Component 3 (combined artiodactyls), Wardell kill and Wardell camp site long bones. Clearly, the Gerstle River Component 3 assemblage is more closely similar to the Wardell camp site with high %differences in humeri, radius, femur, and tibia and low percent differences in metacarpals and metatarsals. There are differences, in that radii and femora are less fragmented in the Gerstle River assemblage, however the total MNE for femora is very low (MNE=1 proximal femur, 2 distal femora).

The overall patterning in carcass economic utility suggests that for meat resources, the Gerstle River Component 3 assemblage exhibits a reverse (bulk) utility strategy for bison, wapiti, and combined artiodactyls. For marrow resources, the available indices yield conflicting correlations, and perhaps could be best described as an unbiased strategy. Given that elements were likely not differentially destroyed based on density-mediated attritional processes, the resulting archaeological faunal assemblage has likely been transformed by differential transport of skeletal elements and associated food resources. This patterning could result from (1) elements not brought to the site, (2) elements brought to the site and differentially destroyed to the point where they cannot be recognized, or (3) elements brought to the site and later removed from the site. As discussed above, hypothesis (2) is considered unlikely. It is hypothesized here that elements with high associated meat-values were likely brought to the site, considering that low-yield elements were also brought to the site. While on-site, these portions were likely processed for the meat, which was consumed and/or dried. If the Gerstle River Component 3 represents a transitional camp or spike camp (Guthrie 1983a:268-273), the anatomical portions could have been prepared for travel at the site, and then brought to the main residential camp location. In any event, the elements associated with these high yield anatomical portions were not present at the site (fragmented or otherwise) after abandonment, e.g. ribs, thoracic vertebrae, and cervical vertebrae. While on-site, the occupants cracked elements with high marrow yields, e.g., tibiae, femora, humeri, radii, metacarpals, and metatarsals, while discarding elements with low marrow yields intact, e.g., tarsals, carpals, scapulae, and phalanges. No grease rendering or further processing of skeletal elements likely occurred at the site (see above and below).

Seasonality

Various methods have been used to infer seasonality of site use based on faunal characteristics (Monks 1981), including presence of flora and microfauna that flourish under certain seasonally dependent temperature and precipitation conditions, mortality profiles, cyclical growth marks (including dental annuli), antler growth, stable isotope analysis, and especially growth-related skeletal development (timing of epiphyseal fusion, tooth eruption, and tooth wear). Tooth eruption and tooth wear patterns have been used to document seasonality in wapiti and bison (Pike-Tay 1991; Todd et al. 1990). Unfortunately, no fetal material or immature wapiti or bison (>2 years of age) were recovered at Gerstle River Component 3, though a mandible fragment from Block W can be aged at 1 year given tooth eruption, which translates to summer death (May-June) (see Murie 1951; Jensen 1999; see next section). Unfortunately, Block W faunal materials cannot at present be linked to a cultural component. No antler was recovered within Component 3, so these season-specific element portions could not be used to infer seasonality.

Guthrie (1983a) and Hoskins et al. (1970) proposed a relationship between sphericity and polish of gastroliths found in loess depositional environments and seasonality. Angular unpolished gastroliths could represent fall deposition, mixed angular and rounded could represent spring and early summer deposition, and rounded and polished gastroliths could represent mid-winter deposition. The gastroliths stratigraphically associated with Gerstle River Component 3 are generally angular, suggesting fall occupation (if the gastroliths are directly associated with bird exploitation), and a single very large gastrolith cluster (n=73) in Area C show sub-rounded to sub-angular and polished gastroliths, suggestive of late fall/early winter occupation (see below).

Paleoindian bison kill sites in the Lower 48 tend to occur in the late fall-early winter (Todd 1991; Frison 1974; Todd 1987), however data from Liscomb and Scottsbluff suggest bison exploitation from late spring to early fall in those localities (Todd et al. 1990). Todd suggests that frozen meat caches may have played an important role in winter subsistence during this period, explaining this distribution (1991:218).

Late Pleistocene/Early Holocene components in Alaska vary with respect to season of occupation. Yesner (1994) suggests a spring occupation at Broken Mammoth CZ 4 (~11500 BP) and a fall occupation at Broken Mammoth CZ 3 (~10200 BP). Guthrie suggests fall-early winter (and perhaps summer) occupations at Dry Creek Components 1 and 2 (1983a:244, 279). Using ground squirrel exploitation parameters and modern caribou and sheep ranges in the Nenana valley, Bowers suggests a late summer to early fall occupation at Carlo Creek CI (Bowers 1980:152-155). Given the data presented above and floral indicators discussed in Chapter 9, seasonality at Component 3 is tentatively estimated as fall.

Age Estimation

A number of techniques can be used to estimate age of mammals, including tooth eruption schedules, tooth wear, suture closure, epiphyseal fusion, antler development, and element size (see Klein and Cruz-Uribe 1984:41-55; Chaplin 1971:75-90). Three techniques were used to estimate age of artiodactyls in Component 3: tooth eruption, tooth wear and epiphyseal fusion of long bones. In addition, analysis of dental annuli through thin-sectioning was attempted. There are limitations for each method with respect to this sample. Only wapiti teeth have been recovered in excavations thus far, and age estimates can only be derived for this group. Regarding epiphyseal fusion, or fusion of each epiphyses (ends) to the diaphysis (shaft), Klein and Cruz-Uribe (1984:43) note that ages of epiphyseal fusion are unknown for many wild populations, age classes defined through this method are imprecise, and unfused ends are more liable to be destroyed in density-mediated attritional processes (see above).

Epiphyseal Fusion of Long Bones

Given the limitations on epiphyseal fusion expressed above, and the generally fragmented nature of the Gerstle River Component 3 assemblage, I have estimated only two age classes, mature (complete epiphyseal union) and immature (incomplete epiphyseal union). Long bone NISPs with extant epiphyses were divided into three groups: complete/fused, broken/unfused, and broken for both proximal and distal epiphyses. "Broken/unfused" included specimens where epiphysis and diaphysis are present and adjacent, but no bone was found between them. This could result from incomplete fusion or deterioration of less dense bone between these element portions. "Broken" included specimens where the epiphysis was present, but the diaphysis and/or the area of epiphyseal fusion was not recovered. This second category cannot be used to directly assess fusion, as the area under consideration is not present. Results are presented in Table 6.13. No proximal ends could be considered unfused, where 11 were complete/fused, with 2 broken for these specimens. Only two bison metacarpals (illustrated in Figure 6.1 and 6.2) and one wapiti radius had broken or unfused distal condyles. A total of 17 distal ends were complete/fused, and 5 consisted of broken epiphyses only. These data suggest that most if not all of the available wapiti long bones suggest the presence of mature individuals, whereas the bison long bones may represent mature and immature individuals. The tooth wear data (see below) confirms that all of the wapiti individuals are adult animals.

Table 6.13 Long bone fusion by NISP for combined artiodactyls.

Element portion	*Proximal*			*Distal*		
	Complete/ fused	*Broken/ unfused*	*Broken*	*Complete/ fused*	*Broken/ unfused*	*broken*
Humerus	0	0	0	3	0	0
Radius	3	0	1	4	1	0
Metacarpal	3	0	0	3	2	1
Femur	0	0	1	0	0	2
Tibia	0	0	0	2	0	0
Metatarsal	5	0	0	5	0	2

Dental Annuli, Tooth Eruption and Wear, and Tooth Crown Height

A total of 63 artiodactyl teeth were recovered from Component 3, including 2 left mandibles, 3 right mandibles, 2 left maxillae, 5 right maxillae, and an additional 10 isolated teeth (Table 6.14, Figures 6.39 and 6.40). All tooth rows are cervid on the basis of morphology, including presence of prominent lingual cervical bulges on molars (crown tapers to occlusal surface), absence of tall lingual accessory cusps, and lower, less robust crowns (Hillson 1995: 12, 22). Evidence of bovine hypsodonty was not observed. Tooth row pairing can be assessed by size and morphology, but are here assessed on the basis of these and spatial proximity. UA2000-774 and 775 (R and L mandibles) were located within 10 cm of each other. UA2001-646 and 647 (R and L maxillae) were located within 20 cm of each other.

Table 6.14 Tooth rows and isolated teeth, ordered by faunal cluster.

Provenience units	*Type*	*Associated teeth*	*Faunal cluster*
UA2000-54-774	R mandible	P2, P3, P4, M1, M2, M3	F1
UA2000-54-775	L mandible	P2, P3, P4, M1, M2, M3	F1
UA2000-65-141	?	1 molar or premolar	F1
UA2002-62-324	? mandible	1 incisor	F1
UA99-62-455	L maxilla	P2, P3, P4, M1, M2	F2
UA2001-71-604	L maxilla	M3	F3
UA99-62-614+311	R mandible	P4, M1, M2, (+M3)	F3
UA99-62-312	R maxilla	P4, M1, M2	F3
UA99-62-246	?	1 molar or premolar	F3
UA99-62-382	?	1 molar or premolar	F3
UA99-62-658	?	1 molar or premolar	F3
UA99-62-768	?	1 unidentified tooth	F3
UA2000-54-12	R maxilla	P3, P4, M1, M2	F4
UA2001-71-227	R maxilla	P4, M1, M2, M3	F4
UA2001-71-646	R maxilla	3-5 premolars/molars	F6a
UA2001-71-647	L maxilla	P2, P3, P4, M1, M2	F6a
UA2002-62-473	R mandible	M3	F6a
UA2003-54-140	?	1 molar or premolar	F6a
UA99-62-45, 47, 49	R maxilla	P3, P4, M1, M2	F7
UA99-62-851, 853	? mandible	3 incisors	F7
UA2003-54-50, 86, 90	L mandible	P2, P3, P4, M1, M2	F8

Three avenues of inquiry were pursued to assess seasonality and age of the wapiti from Component 3: thin-sectioning, teeth eruption, and teeth wear. An attempt was made to assess seasonality or age through thin-sectioning and analysis through Matson Laboratories, Inc. General annuli-age/seasonality relationships have been examined for wapiti (Pike-Tay 1991; Burke 1995; Azorit et al. 2002) and bison (Novakowski 1963; Pigage and McKenna 1979) (see Grue and Jensen (1979) for a general review). After consultation with Gary Matson and Heddy Gray of Matson Laboratories, three tooth samples were sent in January 2004 (UA2001-71-647E, UA99-62-455C, and UA99-62-614B). Gray noted that archaeological specimens typically did not survive the decalcification process, and I authorized an attempt to section UA2001-71-647E (maxillary P2) because the collagen yield might be high enough for the tooth to survive, and the total sample size was relatively high (n>60), so experimentation on one sample was considered acceptable, and the potential data would be useful. Gray began the process, using a water-cooled diamond-bladed saw, but the tooth started to crumble, and it failed the test. The samples were later returned. In the future, thin-sectioning some teeth specimens by first encasing them in resin may be attempted in order to strengthen the teeth prior to cutting/sawing. Stan Freer and Greg Monks, associated with the University of Manitoba laboratory that specializes in this type of thin-sectioning were contacted, but the lab was no longer accepting samples.

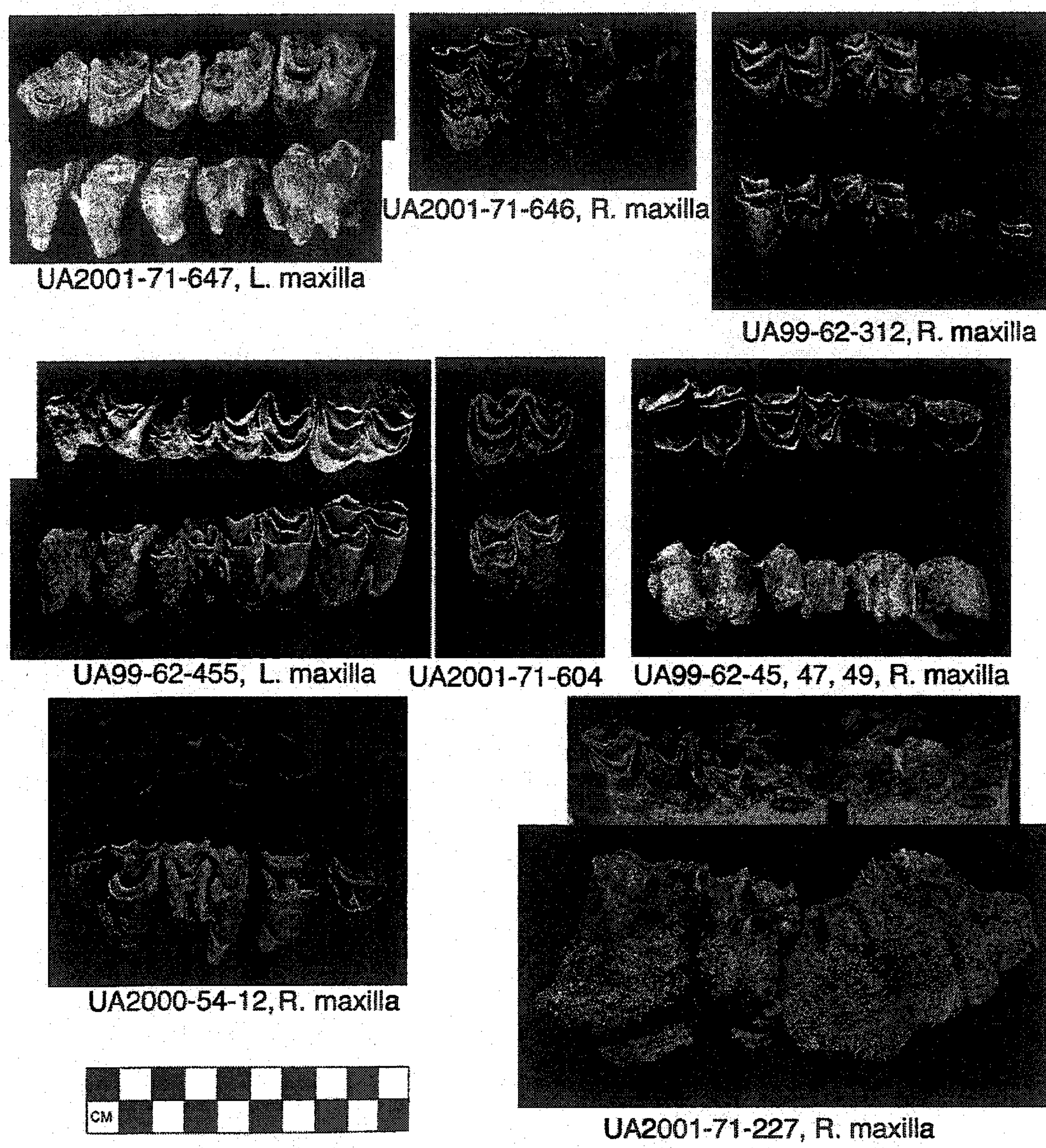


Figure 6.39 All Component 3 maxillary tooth rows, lingual and occlusal views. Note: some teeth are not photographed due to extreme fragmentation (consult Table 6.13 for teeth totals).

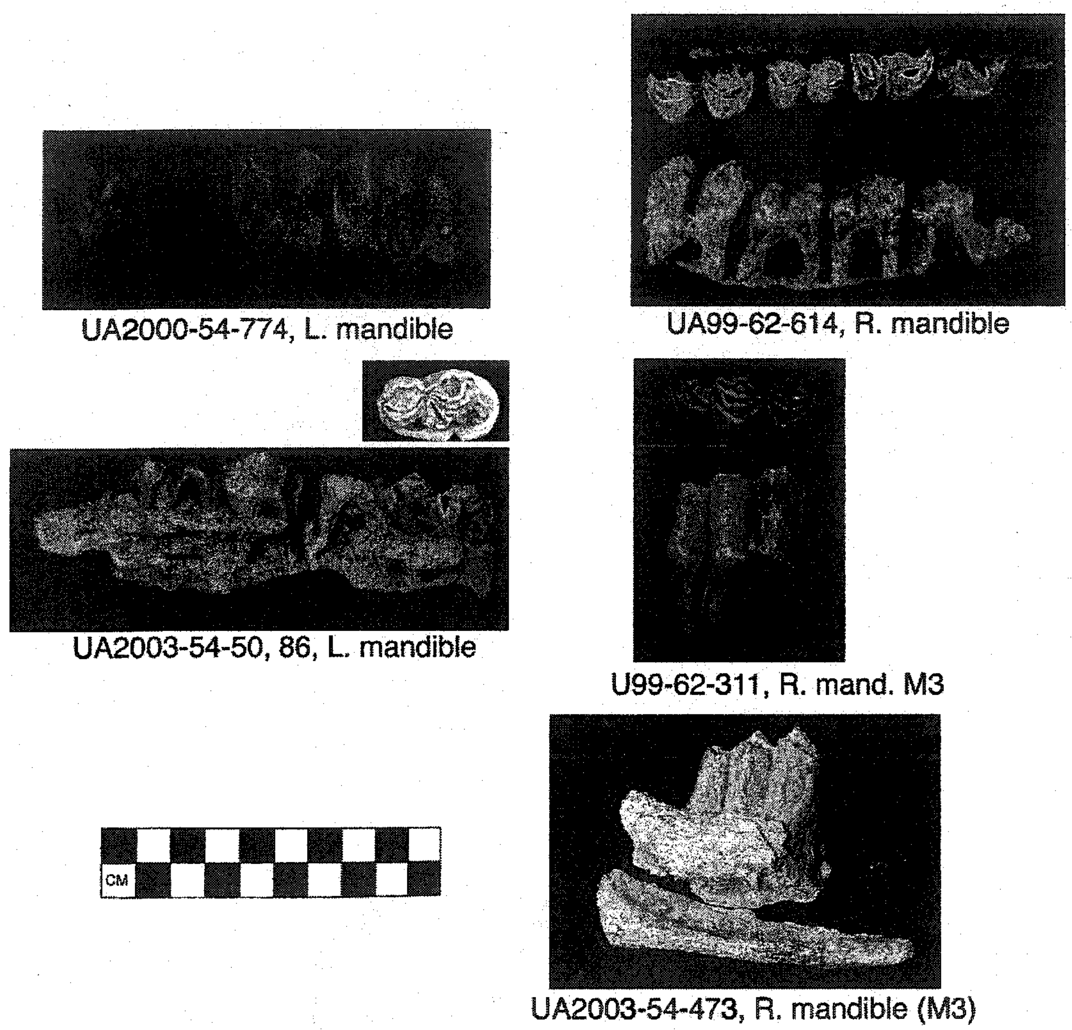


Figure 6.40 All Component 3 mandibular tooth rows (except UA2000-54-775), buccal and occlusal views.

Deciduous and permanent tooth eruption in *Cervus elaphus* have been documented by Lowe (1967), Hillson (1986), and Jensen (1999). Unfortunately, no deciduous teeth were present in the Gerstle River Component 3 assemblage. Following Jensen's estimation of tooth eruption in wapiti of North Dakota (Jensen 1999) and others (see below), M1 in wapiti erupts at 6 months, M2 at 12 months, and M3 at 18 months. In Gerstle River Component 3 mandible samples, M3 is present (though R mandible UA99-62-614 contains P4-M2, but a R mandibular M3 was located nearby and likely relates to this specimen) and deciduous P4 is absent, indicating minimum age of 2.5 years (Jensen 1999). No juvenile specimens were present in Gerstle River Component 3; all teeth were considered to come from adult animals. Based on morphological comparison of tooth wear, Gerstle River Component 3 mandibular specimens fall within the 3.5 year old class and 4.5-8.5 year old classes (the oldest age classes in Jensen 1999).

Using Klein and Cruz-Uribe's formulae for wapiti (red deer) crown height and age estimation (1984:44-57), I estimated age at death for 17 mandibular and maxillary M1 and M2 from nine tooth rows (see Table 6.14). The equations were primarily developed for use aging mandibular teeth, but maxillary teeth have provided reasonably accurate results using these formula (Gifford-Gonzales 1991), and are used here for both mandibular and maxillary teeth given the lack of any suitable maxillary wear/age formula. All recovered teeth are worn, and M2 has erupted and has worn within each tooth row, indicating a minimum age of about 12 months. The lack of deciduous P4 (generally shed around 26 months) indicates minimum age of about 26 months (2.2 years) for all individuals (Quimby and Gaab 1957; Lowe 1967; and Mitchell 1967; cited in Klein and Cruz-Uribe 1984). Given the presence of adult wapiti, the following formula was used:

$$AGE = AGEpel - 2(AGEpel-AGEe)(CH/CH0)+(AGEpel-AGEe)(CH^2/CH0^2)$$

where,

CH = variable crown height (in tenths of millimeters)

CH0 = initial (unworn) crown height (M1=270, M2=296, M3=310)

AGEe = age at which permanent tooth erupts (M1=6 months, M2=12 months, M3=30 months))

AGEpel = maximum possible age of individual (192 months)

Initial crown heights were 27.0 mm for M1, 29.6 mm for M2, and 31.0 mm for M3 (Klein et al. 1983), with M1 erupting at 6 months and M2 erupting at 12 months. Maximum age (or age at potential ecological longevity) is estimated at 192 months (16 years) (Klein and Cruz-Uribe 1984:48-50). Klein and Cruz-Uribe (1984) measure the unworn first lobe crown height of the buccal side of mandibular teeth and the lingual side of maxillary teeth. This study followed that procedure, however given extensive fragmentation, maximum crown height (generally on the second lobe) was recorded. This may lead to an overestimation of age. Klein and Cruz-Uribe (1984:51) note that given different age at first occlusion of M1 and M2, the former may overestimate age and the latter my underestimate age (by 9-14%) (see also Klein et al. 1983).

Therefore, the values in Table 6.15 list the age estimates for the 192 month estimate for both teeth, and 168 months for M1, 210 months for M2, and 215 months for M3.

Due to the uncertainties relating to crown preservation and fragmentation, these values should be seen as estimates (see Klein et al. 1983; Steele 2002). For those tooth rows where multiple teeth could be measured, the results were in relatively close agreement (with differences ranging from –22 to +46 months). M1 and M2 differences within the same tooth row averaged 20 months, M2 and M3 differences averaged 8 months, and M1 and M3 differences averaged 32 months. Klein et al. note that M1 is the first to erupt, is the lowest crowned, and is heavily worn well before age of potential longevity (1983:53). Therefore, when estimating age, M2 and M3 values are averaged for tooth rows where these teeth are present.

Table 6.15 Crown height and age estimation.

Provenience Units	*Tooth*	*L (mm)*	*Crown height[10] (mm)*	*Age at death (months) using AGEpel=192*	*Age at death (months) using AGEpel=168, 210, and 215*	*Age estimation (years)*
			Tooth Rows			
UA2000-54-12 L maxilla	M1	26.1	14.6*	45	40	2.5
	M2	29.1*	21.9	28	30	
UA2000-54-774 R mandible	M1	21.9	21.6	13	12	2.1
	M2	30.1	29.6	20	20	
	M3	37.2	31.8	30	30	
UA2001-71-646 R maxilla	M2	-	13.1	69	75	6.3
UA2001-71-647 L maxilla	M2	28.3	14.2	62	67	5.6
UA2003-54-50 L mandible	M1	22.7*	6.7	111	98	8.2
UA99-62-45+49 R maxilla	M1	28.5	18.4	25	22	3.7
	M2	30.1	18.4	41	44	
UA99-62-312 R maxilla	M2	28.7	15.0	58	62	5.2
UA99-62-455 L maxilla	M2	29.8	24.9	22	23	1.9
UA99-62-614 R mandible	M1	24.4	8.5	93	82	3.4
	M2	30.2	19.0	38	41	
UA99-62-311 R mandible	M3	39.8	25.5	35	36	3.0
			Isolated teeth			
UA2001-71-604 L maxilla	M3	28.6	15.8	69	74	6.2
UA2003-54-473 R mandible	M3	39.8	28.6	31	31	2.6

* minima due to tooth deterioration

The proximity of the L and R mandibles (UA2000-54-774 and 775) and L maxilla (UA99-62-455) could indicate that these are from the same animal. The two adjacent maxillae (UA2001-71-646 and 647) yield very similar age estimates (74 and 67 respectively) and are almost certainly from the same animal. UA2001-71-604 (L maxillary M3) may be linked with

UA2001-71-647 (L maxilla P2-M2), as they have nearly identical wear. The results indicate that three age groupings are present, all adults, 1.8-3.7 years (n=6 tooth rows and one isolated tooth), 5.2-6.3 years (n=3 tooth rows and one isolated tooth), and 8.2 years (n=1 tooth row). Minimum numbers of individuals for each age class given sided maxillae and mandibles are three for 1.8-3.7 year class, two for 5.2-6.3 year class, and one for 8.2 year class. This may suggest that total wapiti MNI for Component 3 is six rather than five, however given greater variability in tooth wear in older animals, the separation of the 5.2-6.3 and 8.2 year classes may not be so sharply defined, especially as the 5.2-6.3 group included only maxillae and the 8.2 group was represented by one mandible.

The wear exhibited in the Gerstle River specimens was generally intermediate between the 3.5 year old class and 4.5-8.5 year old class (Jensen 1999), suggesting a close agreement between Spinage's formula and the tooth eruption/wear stages. Generally, wapiti can live in the wild to over 20 years (Klein et al. 1983; Loe et al. 2003). An age profile of adult Norwegian red deer based on a large sample (n=2656 individuals) is shown in Figure 6.41 with the Gerstle River samples (data from Loe et al. 2003). The age classes represented by Gerstle River show that the 1.8-3.7 year class is represented by 40% of the adult population, the 5.2-6.3 year class is represented by 8% of the adult population, and the 8.2 year class is represented by about 4% of the adult population, suggesting exploitation of prime to older adult animals.

Construction of mortality profiles and subsequent analysis is considered to highly tentative, as the sample size at Gerstle River is small (>>25, as suggested by Klein and Cruz-Uribe 1984:57), but may have heuristic value given the absence of published mortality profiles for any assemblage dating to the Late Pleistocene or Early Holocene in Alaska. An age distribution of all tooth rows and isolated teeth is illustrated in Figure 6.42. In both catastrophic and attritional models, juveniles are expected to be abundant (Frison 1978; Klein 1982; Stiner 1990). The Gerstle River Component 3 wapiti mortality profile is consistent with a prime-dominated mortality profile (Stiner 1990, 1994), which may reflect selective ambush hunting of prey. Enloe (1993b) suggested that efficient weaponry able to kill at a long range could be inferred from prime-dominated mortality profiles. Stiner (1994:307) notes that this type of pattern may also reflect "planned use of space," and cooperative labor, but there is no natural topographic constriction nearby, except for the low saddle between Gerstle River hill and the hill

[10] Buccal crown height of mandibular teeth and lingual crown height of maxillary teeth.

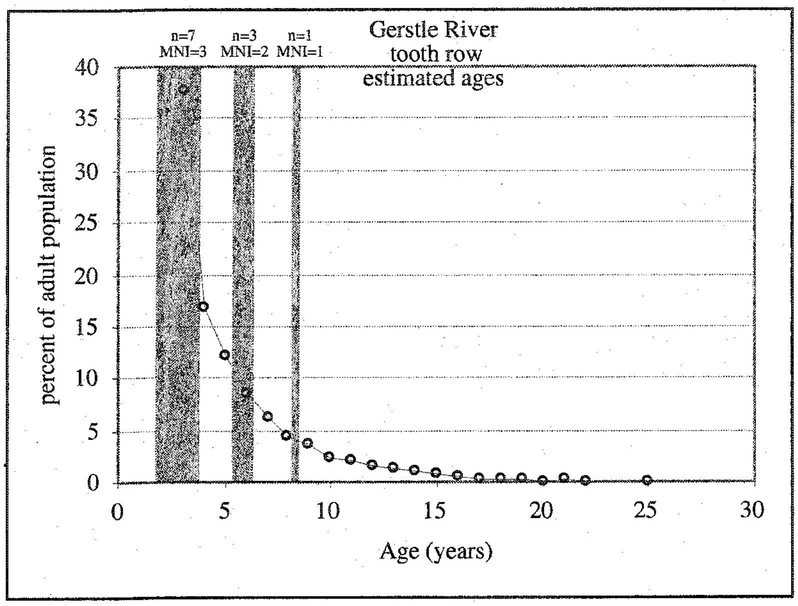


Figure 6.41 Adult *Cervus elaphus* demographic age profile (n=2,656 individuals) with Gerstle River samples (from Loe et al. 2003).

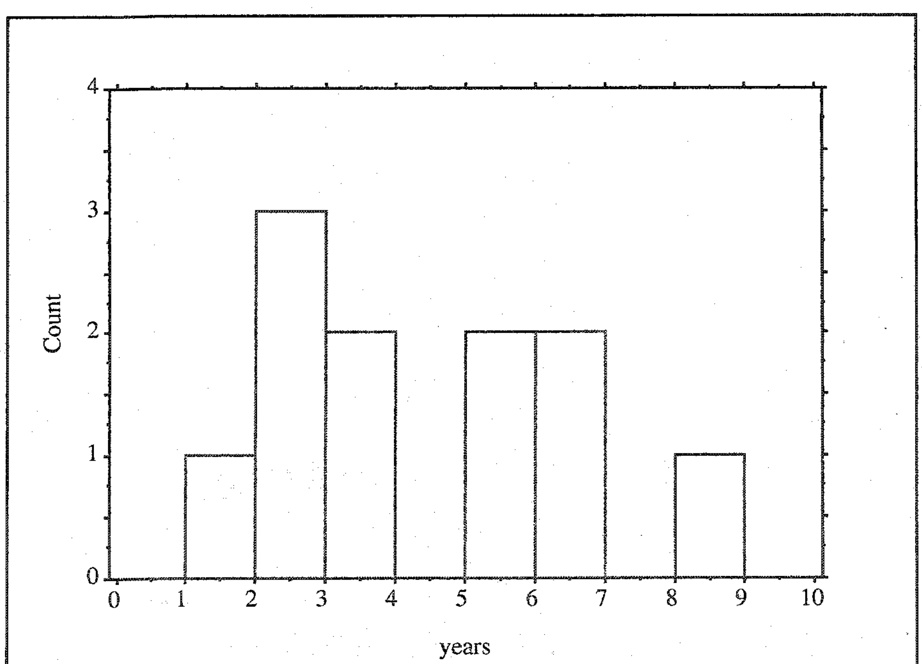


Figure 6.42 Age distribution of *Cervus elaphus* tooth rows (n=9) and isolated teeth (n=2).

located about 2 km to the east. At the very least, the age structure strongly argues for efficient human hunting practices, and offers further evidence against a carnivore-derived faunal assemblage.

It is interesting to note that of the other published Late Pleistocene components (Dry Creek Components 1 and 2), only adults were hunted. Dry Creek Component 2 bison remains consisted of a minimum of two adults, aged 4.5 and 9.5 years (Guthrie 1983a:243). Dry Creek Component 1 wapiti remains consisted of two animals, one with medium tooth wear and the other aged greater than 16 years (Guthrie 1983a:252). The sheep at Dry Creek (Components 1 and 2) were generally 3-6 years old (Guthrie 1983a:218, 220). While the sample size is small, the pattern does seem to suggest hunting preferences for prime adult ungulates during this period.

Sex Estimation

Sex estimation of human hunting-derived faunal assemblages can reflect patterns in hunting behavior in terms of risk and return rates. Unfortunately, most of the common techniques for sex estimation could not be used on the Gerstle River Component 3 assemblage. No antler was recovered in Component 3, and the wapiti occipital cranial fragment and maxilla fragments do not cover the area of the pedicle. The overall sizes of the bison and wapiti remains were generally larger than the adult female plains bison and adult male wapiti comparative specimens. While incisors were present in the assemblage, no ungulate canines were identified.

One alternative to estimating sex is size differences in postcranial bone. The Component 3 assemblage is highly fragmented, and only one complete long bone element is present. Metapodials have the highest MAU values (after maxillae) and offer an opportunity to assess size differences among wapiti and bison specimens. The three measures considered here are distal articular breadth, medial articular depth and antero-posterior condylar width. Distal articular breadth is measured at the greatest breadth of distal condyle medio-laterally, and thus both condyles must be present and attached to the diaphysis or each other to obtain the measurement. Medial articular depth and antero-posterior condylar width are measured on a single condyle. The ratio of these two variables clearly separates bison and wapiti; in bison, the measures are approximately equal, in wapiti, the antero-posterior measurement is greater than the medio-lateral measurement (see Brown and Gustafson 1979:93). Figure 6.43 shows a scatterplot of distal medio-lateral width and medio-lateral width of one condyle:antero-posterior condylar width. The

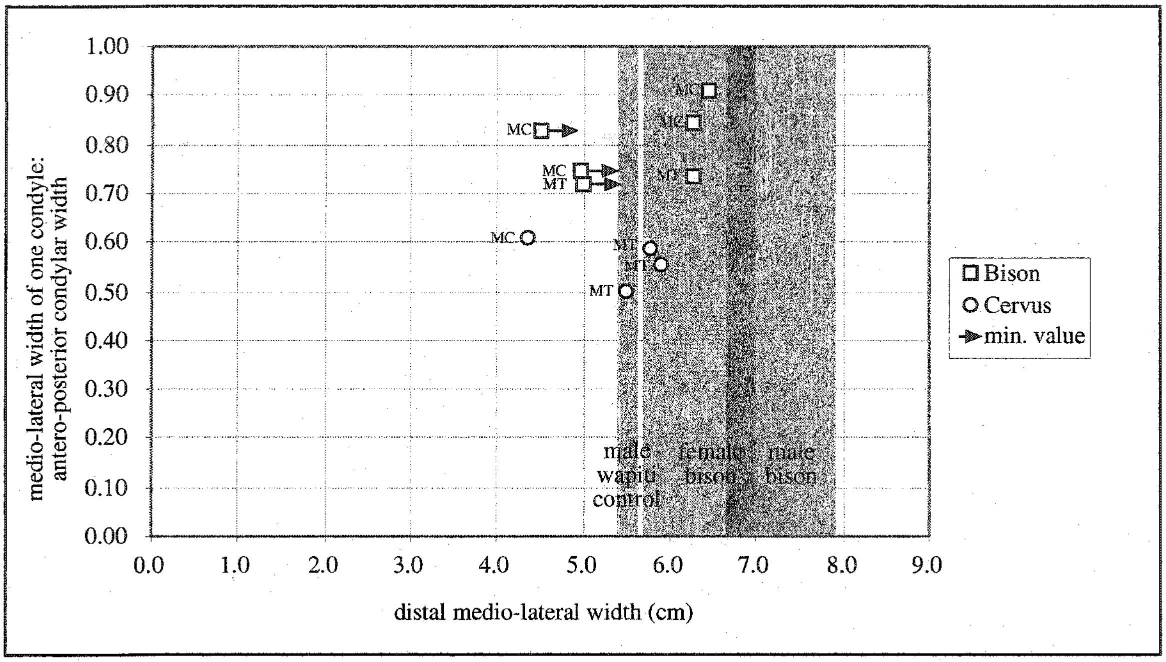


Figure 6.43 Distal metapodial measurements, distal medio-lateral width and medio-lateral width of one condyle: anterio-posterior condylar width per taxon (adult bison distal medio-lateral width estimations from van Zyll de Jong 1986:table 11)

separation of bison (0.7-0.9) and wapiti (0.5-0.6) is clear. Three of the specimens could only be given minimum measurements for distal medio-lateral width as both condyles were separated from each other or from the metapodial diaphysis, or where only one condyle was present. Metapodial distal medio-lateral width ranges for male and female Bison bison specimens are from van Zyll de Jong (1986:table 11) and the modern male wapiti is the comparative specimen from the UAM Mammalogy Laboratory.

For the three bison specimens where both condyles were present and attached, they fall within the adult female bison range (5.7-7.0 cm). The three wapiti metatarsals fall near the male wapiti control (an adult male *Cervus elaphus nelsoni* from Yellowstone National Park, Wyoming) at 5.4-5.5 cm. A single metacarpal (with fused epiphyses) was considerably smaller than the other specimens, suggesting that both adult male and female wapiti were taken.

Gastroliths

Discrete clusters of small pebbles inferred to be gastroliths on the basis of size, shape, and clustered distribution in an aeolian environment, were found within strata Y4a and Y4b at Gerstle River Lower Locus. They show a unimodal distribution, around Y4 level 2 (10-20 cm below R4) (n=14 clusters), with 4 clusters found in Y4 level 1, 2 found in Y4 level 3, and 1 each found in Y4 levels 4, 5, and 6. There is likely a bias in gastrolith recovery, with those associated with artifact levels more likely to be recovered. Gastroliths are stratigraphically associated with Components 2 (2 clusters), Component 3 (20 clusters), and Component 4 (1 cluster). This clustering around Y4 level 2 may reflect exploitation of birds at Gerstle River (see Guthrie's discussion of gastroliths at Dry Creek (1983a:274-282), but in the absence of avian faunal remains directly associated with cultural materials, the presence of gastroliths in non-cultural strata, and recovery bias, I argue that no birds were utilized during the occupations. In the present, numerous sparrows utilize the site, and various waterfowl and upland species (including grouse and ptarmigan) are found in the area (Magoun and Dean 2000).

Gastrolith clusters were found at 12 discrete locations within Y4a cultural horizon, and an additional seven groups were screened from 0.25 m^2 quads (Figure 6.44). The groups were found in two general areas: four clusters were grouped tightly near Feature 1 in Area A and five clusters (and four screened clusters) were widely scattered near Feature 12 in Area C and Feature 9 in Area B. An additional cluster was found near Feature 3, one cluster was screened in Block J, and another was screened in Block A, the latter two are not near any feature or lithic concentration.

As Guthrie noted with respect to small pebbles found clustered at the Dry Creek site, "loess silt and small sand-size range of interior Alaska [sediments] makes gastroliths extremely important as seasonal indicators of site use" (1983a:274). Sphericity and polish was used to infer seasonality at Dry Creek (Component 2), where ptarmigan and grouse gastroliths are angular in fall, when they are generally acquired, rounded over winter, with a polish in mid-winter, and are mixed rounded-polished and angular-unpolished in spring and early summer (Guthrie 1983a:274-275; see also Hoskins et al. 1970). Guthrie did not specifically describe waterfowl gastroliths, but the presence of numerous waterfowl species at Broken Mammoth CZ3 and CZ4 suggests that these should be taken into consideration.

Considering only the 3-pointed clusters of gastroliths in Component 3, they varied in number: 3, 4, 4, 5, 7, 7, 8, 10, 11, 11, 18, and 74 for a median of 8 per cluster, but were generally

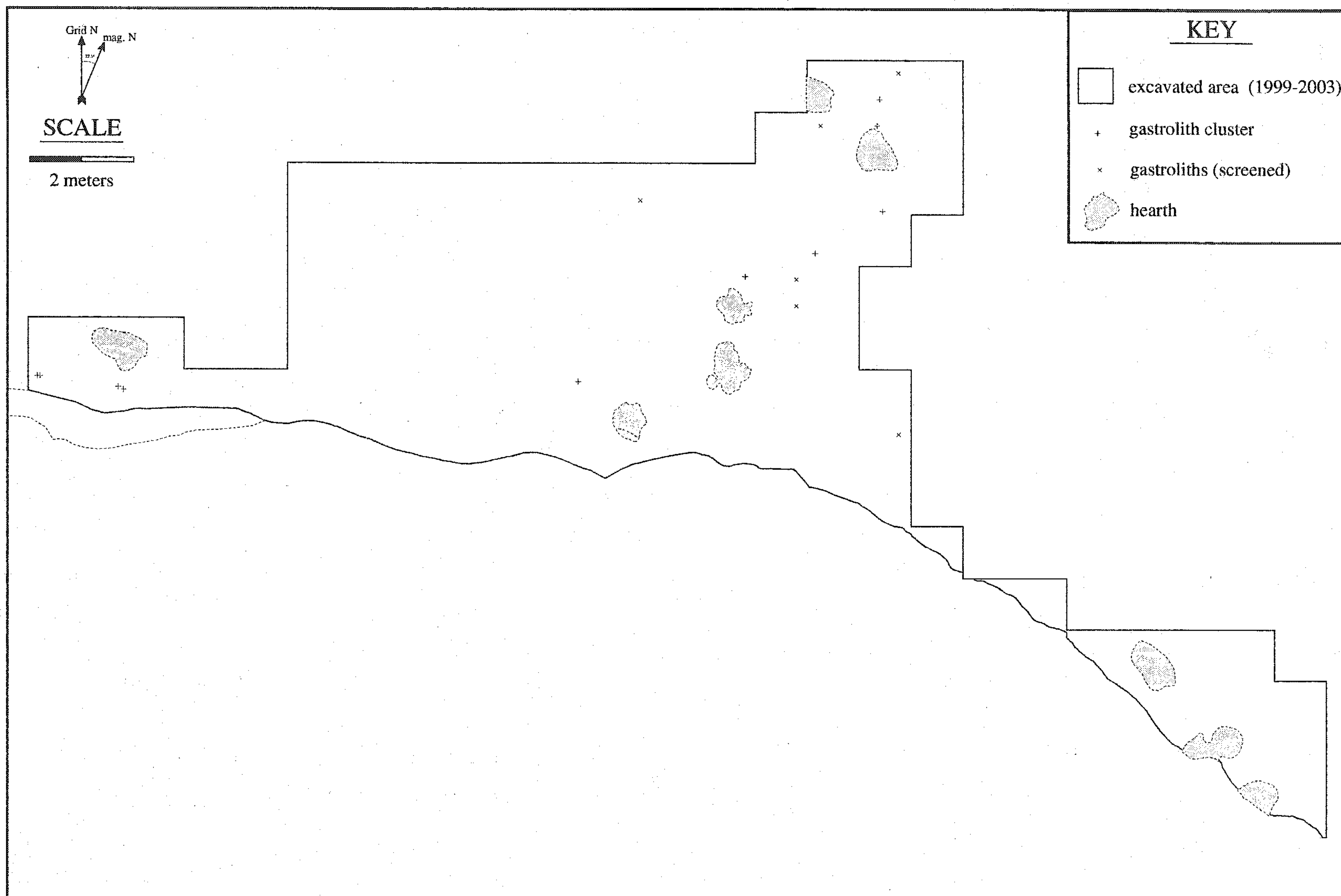


Figure 6.44 Gastrolith distribution.

found within a 2 cm diameter area. Most of the pebbles ranged in maximum dimension from 1-5 mm and were angular to sub-angular in sphericity, suggesting fall deposition, however, the large cluster found in N51E49 (UA2002-62-24) were considerably larger (3-9 mm) and were more rounded (sub-rounded to sub-angular) and polished. The large number of pebbles and their morphology may suggest that these were from different size birds at a different season than the others, perhaps mid-winter (Guthrie 1983a:274). Further work needs to be done to clarify the relationship between these possible gastrolith clusters and Component 3.

Discussion

Post-Occupational and Post-Depositional Taphonomic Processes

In this analysis, several possible agents of bone accumulation and modification were assessed against various datasets. Possible agents include carnivore accumulation, occupation carnivore (dog) scavenging, post-occupation carnivore scavenging, human butchery and processing, and post-depositional taphonomic destruction. It is clear that the faunal assemblage did not form by means of carnivore accumulation. The definite association with human produced lithic tools, hearth features, the narrow range of large-bodied ungulates (wapiti and bison), and occurrence within an open-air hill top setting (rather than a cave or den) all indicate human accumulation of the faunal assemblage.

The association of dogs and early populations of Beringia and Alaska is unclear, though domesticated dog apparently originated in East Asia around 15,000 years BP, given relatively large genetic variation in this area (Savolainen et al. 2002). Leonard et al. (2002:1616) found that prehistoric American and Eurasian dogs have a common ancestor, likely in the East Asian wolf (Savolainen et al. 2002); and this implies that the humans brought along multiple haplotype lineages across Beringia in the Late Pleistocene. Vereshchagin (1979, cited in Goebel and Slobodin 1999) documents dogs at Ushki 1, level VI (dating to ~10,600 BP) in Kamchatka. However, the oldest dog-human association in the New World has been found at Danger Cave, Utah, dating to around 10,000 BP (Grayson 1988). A few wolf specimens (classed as *Canis dirus*, or dire wolf) were found with other carnivores (*Alopex lagopus*, arctic fox) at Broken Mammoth CZ 3 (~10,300 BP) (Yesner 1994), but no dog specimens were found. The evidence at Gerstle River Component 3 suggests that dogs were not part of the occupation(s). No canid specimens have been found at Gerstle River Component 3. No partially digested bone fragments were observed. Gnawing marks, pitting, scoring, crenelated, scalloped or jagged lateral edges of long bones, gnawed epiphyses, channelling, were not observed in Component 3. Breakage patterns of thick-walled long bones, such as near the distal epiphyses of humeri are suggestive of human-caused destruction rather than carnivore-caused destruction (Todd and Rapson 1988:314-319). The presence of human-burned faunal remains also may be factor in the lack of subsequent carnivore attrition, as burned bones generally have less available nutrients (Lupo 1995). In sum, carnivore modification (as part of the occupation or post-occupational) is not suspected to be a major factor in the formation of this assemblage (see below).

Post-depositional taphonomic destruction relating to *in situ* weathering, sediment abrasion, and sediment crushing is not considered to be a major factor in the preservation of the Component 3 assemblage. This is supported by the variability in survivability (from complete large elements to small fragments of cancellous bone), the relative homogeneity of surface condition and weathering patterns, and the %survivorship of element portions with low mineral bone density. Abrasians and striations typical of damage due to sediment particle abrasion were not observed. While freeze thaw and wetting and drying while buried may have led to some bone deterioration and disintegration, the %survivorship and bone mineral density analysis, and the relatively high %MAU values of low density bones suggests that this bone loss was minimal.

Various datasets indicate that no large-scale natural taphonomic agent disturbed the spatial patterning at Gerstle River Component 3 (see Chapter 4). Artifact concentrations have varied content (tiny lithic flakes, large cobbles, hearths, and large and small bone fragments) and are found within a tight vertical distribution within stratum Y4a. No size sorting of faunal materials or flakes is noted within Component 3. Many of the bones were still articulated. The spatial integrity of the faunal remains is highly resolved. With this high resolution and control on density-mediated attrition, inferences can be made about human processing patterns at the site and hunting strategies of the population that occupied this site.

Models of Faunal Processing

Carcass resources available from wapiti and bison can be broken down into food resources and material resources. Food resources include meat, fat, marrow, grease, juice, brains, blood, and viscera (including organs). Material resources (for tools, clothing, etc.) include hide, hair, sinew, bone, horn/antler, hooves, and teeth (after Lyman 1987). In order to reduce and modify the carcass into anatomical units for transport, consumption, storage, and/or further processing (drying, etc.), various butchery processes need to occur. Lyman details various general processing activities and constraints on these activities (1987; 1994a:294-314). In the analyses below, carcass reduction is modeled using Lyman's framework on the basis of two components, (1) spatial processing model, and (2) faunal trajectories from which butchery and transport decisions are modeled.

Spatial Model of Faunal Processing

Modeling butchering behaviors at Gerstle River Component 3 requires integrating a number of analyses, including fragmentation, articulation, refitting, burning and other modifications, skeletal element analysis, economic utility analysis, and bone density and %survivorship analysis, all integrated through spatial analysis. Based on the data, hypotheses, and statistical tests detailed above, I propose the following model to explain the patterning observed in the Gerstle River Component 3 faunal assemblage (see Figure 6.45). The model incorporates three stages of butchering activities, (1) carcass portions brought to the site and placed in a central "staging" area, (2) element groups removed from carcass, taken to ancillary processing areas, where marrow was extracted, and (3) some specimens were placed within areas that functioned as disposal areas, which were spaced further from the areas of occupancy (denoted by hearth features and lithic items).

Three types of faunal clusters were identified in the course of this analysis: (1) staging area, (2) processing areas, and (3) dumps or refuse areas. One staging area (F5) was defined on the basis of articulated low-yield elements, relatively little fragmentation, and relative absence of long bones. Five processing areas (F1, F3, F4, F6b, and F9) were defined on the basis of association with lithics and hearth features, low average weights (per fragment), high percentages of long bone ends and associated shafts, dominance of long bones, high percentages of burned bones, and generally higher levels of fragmentation. Additionally, the clusters are centered on hearths that have extensive amounts of burned and calcined bone directly within their matrix. Two dumps or refuse areas (F2 and F7) were defined on the basis of lack of association with lithics and features, high degree of fragmentation, and high percentages of long bone shafts, and lack of burned bone. Classification of cluster F6a is discussed below.

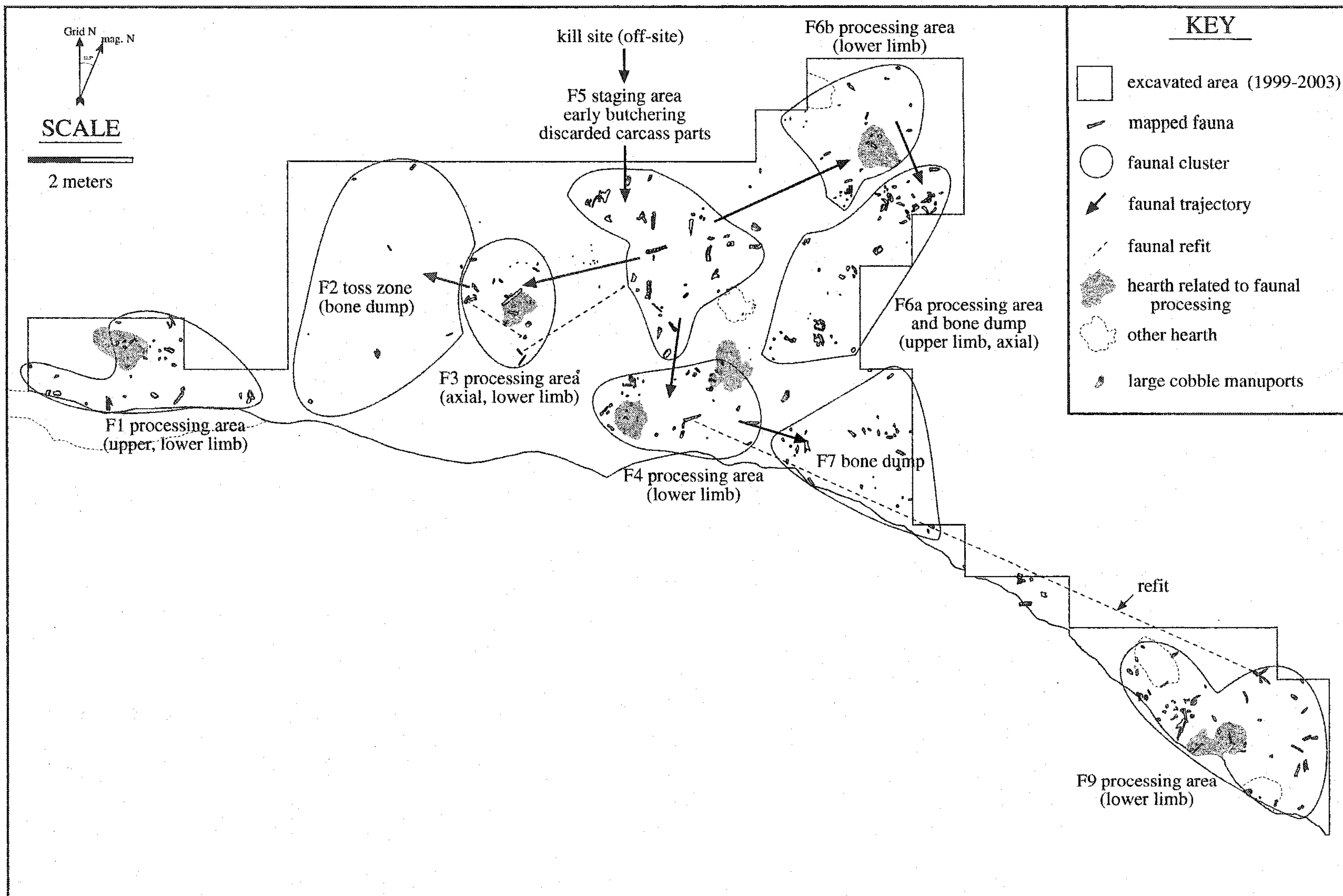


Figure 6.45 Faunal spatial-functional model.

After the bison and wapiti were killed off-site, several carcass portions (limbs, axial portions, etc.) were brought to the site and situated within faunal cluster F5, which functioned as a temporary storage area. Meat was removed into usable portions and dried or cooked and eaten, and/or taken from the site. From this initial area, element portions and element groups (largely limbs) were removed from cluster F5 and transported to at least three and perhaps five areas (faunal clusters F3, F4, F6b, F9, and perhaps F1), where various types of processing took place. Four large cobbles were located at the periphery of cluster F5, and these may have been used to butcher the carcass segments (see Figure 6.45). Clusters F1, F4, F6b, F9 (and to a lesser extent, F3) saw very similar types of processing activities, where marrow was extracted from long bones. Cluster F3 was somewhat different in that axial and teeth units predominate (by weight), suggesting that a different type of processing occurred there, although long bones were still present (including two bison metapodials). Faunal debris from cluster F3 was discarded in a "toss zone" to the west and downslope (cluster F2), and faunal debris from cluster F4 were discarded to the east (cluster F7). These disposal areas were located on the periphery of the site occupation based on the feature and artifact distribution. Both disposal areas had no burned bones and similar high percentages of long bone shafts and relative lack of articular ends. The disposal areas are somewhat different in character: F2 was a diffuse toss zone with largely teeth/maxilla/mandible specimens, and F7 was a more dense area with fragmented long bones predominant.

Two clusters remain somewhat ambiguous, F6a and F6b. While F6b shares many faunal characteristics with the other processing areas (F1, F3, F4, F9), there is no clear spatial "break" with F6a to the south. F6a is interpreted to be either (a) a continuation of the central staging area (F5) or (b) a specialized processing area. Evidence for hypothesis (a) includes similarities (between F5 and F6a) of high average weights, high weight densities, fewer total long bones (relative to other clusters) but highest percentages of upper long bones, near absence of burned bones, and dominance of axial and teeth units. Evidence for (b) includes more fragmented remains and lower NISP weight percentages (more unidentified bone fragments). It is argued here that F6a is probably an extension of the F5 staging area, but with some processing, perhaps removal of the brain (F6a has the only large cranial fragments) and extraction of meat and marrow from upper limb bones located south of Feature 12. Some of the larger faunal fragments may have been tossed to the southwest (downslope) from the Feature 12 area. Cluster F6b is different from the other processing areas in that it has the highest percentage of long bone shafts (and lowest percentage of long bone ends), which could indicate more intensive processing of long bones or a meat-processing strategy which resulted in fragmented long bone shafts.

Articulation is absent for disposal areas (F2 and F7 as expected) and is very high for the staging area (F5). Processing areas F1, F4, and F9 are very similar in articulation (12-15%NISP wt.), but F3 has higher values (largely due to the articulated vertebrae column within Feature 1, and F6b has no articulating specimens, which further suggests different processing occurring within cluster F6b. The similarity in articulation between processing areas F1, F4, F9 and F6a perhaps suggests a similar functional relationship between processing activities and bone articulation in these areas. Very few elements were refit, and most were located very close to each other. However, the presence of a refitted wapiti metatarsal between cluster F4 (in Area B) and F9 (in Area D) supports contemporaneity among the faunal clusters.

The overall spatial patterning at Gerstle River Component 3 suggests contemporaneity of most of the hearth features. Features 1, 3, 5, 9, 12, 13, 14, and 16 may be contemporaneous on the basis of the faunal patterning, in terms of similarities and differences among faunal clusters directly associated with these features. Contemporaneity of Feature 10 (Area A) is difficult to assess with the faunal data, as there is a clear topographic break between Area A and Areas B, C, and D. Feature 18 is also difficult to assess as it lies on the periphery of the main faunal cluster in Area C (F6b), which appears centered on Feature 12. The older age of Feature 18 and these data would suggest that this feature predates the faunal component, or was utilized in a different way (from other hearths) if it is contemporaneous.

These data suggests that Features 1, 3, 5, 10, 12, and 14 were associated with similar faunal processing tasks, namely extracting marrow from limb elements (primarily lower limb), as the faunal remains were centered directly on these features. These features have the highest burned bone percentages among all hearths (5-63% by weight), whereas the remaining hearths have no directly associated burned bone, except Feature 18 with 1% (by weight), which could result from the Feature 12/faunal cluster F6b processing area located one meter away. Features 9, 13, 16 (and 18) were located on the periphery of these faunal clusters and the lack of burned bone directly associated with their matrices gives further evidence of distinct tasks with the other features with respect to faunal processing.

When considering spatial organization within Component 3, wind direction may be an important factor in decisions regarding processing and discard areas. Disposal areas for post-consumption refuse could generally be considered as offensive waste, and might be preferentially located downwind of the main activity areas. Assuming Fall-Spring-Winter occupations, wind directions are typically from the south to east, and generally ESE (see Chapter 3). The disposal area represented by cluster F2 is downwind from the main activity areas at Features 1, 3, 5, and 9. Cluster F7 however is located to the southeast of Feature 5 does not fit this pattern, and may result from a different occupation. Given this and the overall spatial data, cluster F8 may be a continuation of the F7 disposal area to the east.

Differential Butchery Patterns of Wapiti and Bison

Overall, the fragmentation and skeletal element abundance for bison and wapiti are comparable (see above). However, there are differences in bison and wapiti faunal assemblages that may reflect different butchering and/or transport processes. Bison remains are represented by fewer specimens at the site than wapiti, reflected in the NISP/MNI ratio (11.0 for bison vs. 14.6 for wapiti). As noted above, possible explanations for this difference supported by the extant data include differential removal of bison remains away from the site or differential transport of bison remains to the site. In the latter case, bison may have been acquired at a further distance from the site than wapiti. Fragmentation patterns for bison and wapiti are relatively similar (see above); bison do not appear to have been more fragmented than wapiti. Except for cranial and mandible portions, skeletal unit type abundance is relatively similar for bison and wapiti (lower limbs 42-46% of total weight per taxon, upper limbs 31-32%, and axial elements 9-22%). %MAU values for wapiti and bison were significantly correlated (r_s=0.312, p=0.044), indicating that element portion abundance are generally similar and suggesting that bison and wapiti carcasses and anatomical portions underwent the same processes within the site.

Differences in %MAU between bison and wapiti include more bison distal metacarpals, scapulae, and proximal femora, and more wapiti maxillae, mandibles, radii, ulnae, cranium, and distal tibiae. Spatially, bison are distributed in generally different areas than wapiti, though there is some overlap. Most faunal clusters have both bison and wapiti specimens. MNI per cluster were very similar for bison and wapiti, with one bison and one wapiti individual for 6 clusters (67% of total clusters). The relative abundance and fragmentation of metapodials is illustrative of potential differences in butchering activities with respect to taxa. Bison metacarpals are relatively abundant and are represented by primarily distal portions whereas wapiti metacarpals are rare and represented by distal portions. Bison metatarsals are relatively rare and wapiti metatarsals are relatively abundant. These differences could relate to differential transport to the site or differential processing resulting in the destruction or removal of these element portions. In sum, the similarities in the bison and wapiti assemblages at Gerstle River Component 3 outweigh the differences, and the general pattern of processing outlined above likely applies to both bison and wapiti carcass portions brought to the site.

Faunal Trajectories, Butchery and Transport Decisions

Following Vitt (1971) and O'Connor (1993), the following model is used to describe the faunal trajectory within the context of the Gerstle River Component 3 assemblage. Slaughter and primary butchery was carried at off-site at the place(s) of kill or nearby. The kill-site(s) are estimated to be relatively nearby to Gerstle River, given the amount of low yield and heavier elements, given various *schlepp effects* for large ungulate carcasses and antomical portions (Perkins and Daly 1968; Brink 2001). The masses of adult bison (~350-1000 kg) and wapiti (~200-500 kg) indicate that some processing would be necessary to enable transport of these elements from the kill site(s) to the processing site(s). The kill site(s) may likely be along the Gerstle River, which presently flows about one mile west of the Gerstle River site. This area at present is good habitat for bison (Magoun and Dean 2000), and the ADF&G Alaska's Wildlife and Habitat Atlas shows a bison summer and calving range adjacent to the site north and west (ADF&G 1973)

Primary butchery likely consisted of evisceration, horn/antler and hide stripping and recovery, and carcass reduction for the purposes of transporting meat-yielding portions from the kill site(s) to the (nearby) processing areas at Gerstle River. Heads and feet may be considered primary butchering waste (O'Connor 1993:65), and these element portions are present in relatively high abundances at Gerstle River (see Tables 6.4 and 6.5). This abundance suggests that these portions were not treated as waste and were processed further at the site.

Following Vitt's (1971:155-159) description for caribou and moose butchery among the Upper Tanana Athabaskans, a plausible model is constructed for the primary butchery that occurred off-site. Following the animal's death and probably near the site of the kill, the carcass was stripped of its hide, head cut off at lower neck, brisket and ribs removed from both sides, viscera removed, legs cut off at the knees, and fore and hind quarters cut off. The anatomical portions at the end of this primary butchering stage include: (1) head (with or without antler/horn), (2) brisket and ribs, (3) viscera, (4) upper fore and hind limbs (humeri/femora to radii-ulnae/tibiae), and (5) lower fore and hind limbs (metapodials-phalanges). These anatomical portions are similar to those defined by Binford for Nunamiut butchering patterns of caribou (1978a:60), (1) antlers, skull, mandible, (2) atlas, axis, and cervical vertebrae, (3) thoracic vertebrae, (4) lumbar vertebrae, sacrum, and pelvis, (5) sternum and costal ribs, (6) rib slabs, (7) front legs, and (8) rear legs. However, Vitt does not detail the trajectories of vertebrae, innominates, and sacrum in this process. Since the brisket and ribs were removed as a whole from each side by means of cutting along the back and ribs, the vertebral column (and presumably the innominates and sacrum) would be left relatively intact. No further processing of these elements is described in Vitt (1971), and they were presumably left at the site of the kill.

A major unresolved issue about butchery practices at Gerstle River relates to meat extraction (defleshing and filleting). Elements associated with high meat yields, such as cervical and thoracic vertebrae, and ribs are rare or absent. It is unclear whether the majority of meat extraction and consumption or further processing (boiling, roasting, and/or drying) associated with these elements occurred at the kill site, at Gerstle River, or at some other location.

It was at this stage that the carcasses or portions of the carcasses entered into the Gerstle River site. From the skeletal element frequency analysis, almost all portions of the animals were likely introduced into the site with the exception of cervical and thoracic vertebrae and ribs (and skulls and mandibles for bison). These portions are high meat-yielding elements, corresponding roughly to the brisket and ribs. These portions may have been further processed (dried, smoked, etc.) or consumed at the kill site and not transported to the Gerstle River site or were introduced into the site and subsequently transported off-site or stored in an off-site location. The remaining portions of the primary butchering were introduced into the site for further processing. From this stage, the faunal trajectories of each anatomical portion diverged.

The highly fragmented cranial fragments suggest that the brains, a valuable food resource high in nutrition, were extracted, possibly for consumption on-site. No antler or horn was recovered from the site, and it is possible but unlikely that they were differentially removed or processed into tools and subsequently removed from the site. No organic artifacts made from antler, horn, or hooves were recovered. The upper fore and hind limbs were likely stripped of meat and cracked for marrow extraction. The lower limbs were also cracked for marrow (metapodials) and/or discarded (phalanges) on-site. This marrow extraction appears to be the result of mass processing event(s) rather than consumption and marrow extraction within the context of sequential events (see below). Few skeletal element portions are associated with the innards, but they may have been introduced into the site and further processed (washed, dried, roasted, or rendered for fat and grease).

During or after marrow extraction, some discarded elements were deposited in areas corresponding to disposal areas, located further away from the main lithic maintenance and hearth areas. Other faunal fragments were introduced into hearth feature and were burned or calcined within them. Given the charcoal richness of these features and the relatively paucity of burned fauna, it is unlikely that the bone was used as a fuel. Marrow extraction and discard appear to be the final processes affecting the distribution and fragmentation of the faunal remains; bone grease rendering or boiling did not appear to be a major taphonomic agent. Both bone marrow extraction and bone grease rendering are examined below.

Bone Marrow Extraction

Marrow, or bone fat situated in the medullary cavities of long bones, is high calorie food resource, especially important for hunter-gatherers dependent on mammal hunting (Speth 1983). The main signature of bone marrow extraction is the relative abundance of long bones broken at mid-shaft and the relative paucity of complete bones. Clearly, with only one complete long bone and numerous long bones broken along the diaphysis, this pattern is reflected in Gerstle River Component 3.

Enloe (1993a, based on data from Binford 1978a:428-447) provides expectations for differences in bone marrow processing behaviors between *foragers*, where the food was prepared for immediate consumption, and *collectors*, where processing occurred for the purpose of storage and later consumption. Enloe does conflate the issues of these general economic strategies with sequential processing and mass processing (see Enloe 1993a:84), but the actualistic experimental results can be used for assessing the general practice of marrow extraction at Gerstle River and potentially for evaluating whether the faunal remains of the multiple individuals were processed at one time or sequentially at different times. The utility of Enloe's approach is that it is based on bone splinters, which are very common in the archaeological record, including in the Gerstle River Component 3 assemblage.

Figure 6.46 shows long bone %NISP for a marrow extraction mass processing area at Palangana site and two meal midden areas at Palangana and Bear sites (Binford 1978a; data presented in Enloe 1993a). The combined Gerstle River artiodactyl %NISP seem to correspond more to the mass processing pattern with low percentages of upper limb bones and high percentages of metapodials. Differences in the Gerstle River assemblage vs. the mass processing area at Palangana include higher pecentages of phalanges, metacarpals, and low percentages of unidentified metapodial fragments. Figure 6.47 shows average length of long bone fragments for all four samples. A similar pattern of larger bone fragments for the mass processing area at the Palangana site and Gerstle River Component 3 assemblage vs. the relatively smaller bone fragments found in the middens. While better preservation and hence more comprehensive identification may be possible for the ethnoarchaeological data, the fact that the unidentified long bone fragments are still relatively higher for the Palangana mass processing area and Gerstle River Component 3 supports the similarities. Using these two variables, %NISP and average length, the long bone splinters at Gerstle River Component 3 appear more similar to the pattern of the mass processing area and dissimilar to the meal midden areas. Thus, the patterning of long bone splinters at Gerstle River Component 3 may reflect an economic strategy of mass processing for marrow and perhaps transport or storage for future consumption events, rather than sequential processing relating to immediate consumption. While these data constitute a circumstantial dataset for addressing frequency and timing of processing events, it does lend tentative support for marrow processing of multiple individuals of large game at one time, after meat was extracted from the carcasses.

Bone Grease Rendering

Several expectations related to bone grease rendering have been put forward by various archaeologists, including the presence of numerous small bone fragments, abundance of thermally altered rocks, and associated hearth features (Vehik 1977; Binford 1978a; Jodry and Stanford 1992; Brink 1997) based on ethnographic bone grease rendering data (Peale 1871; Leechman 1951; Zierhut 1967). However, Church and Lyman (2003) have found that bones fragmented to 4 cm, 2 cm, and 1 cm rendered 80% of their available grease after 3 hours of cooking. Bones sawn into three units: epiphyses and diaphysis were the least efficient of all samples. They found that smaller fragments (≤ 5 cm) are more efficiently rendered for their grease content, but that smaller pieces do not increase efficiency (Church and Lyman 2003:1080). In any event, the lack of thermally altered rock and absence of pit remains suitable for boiling

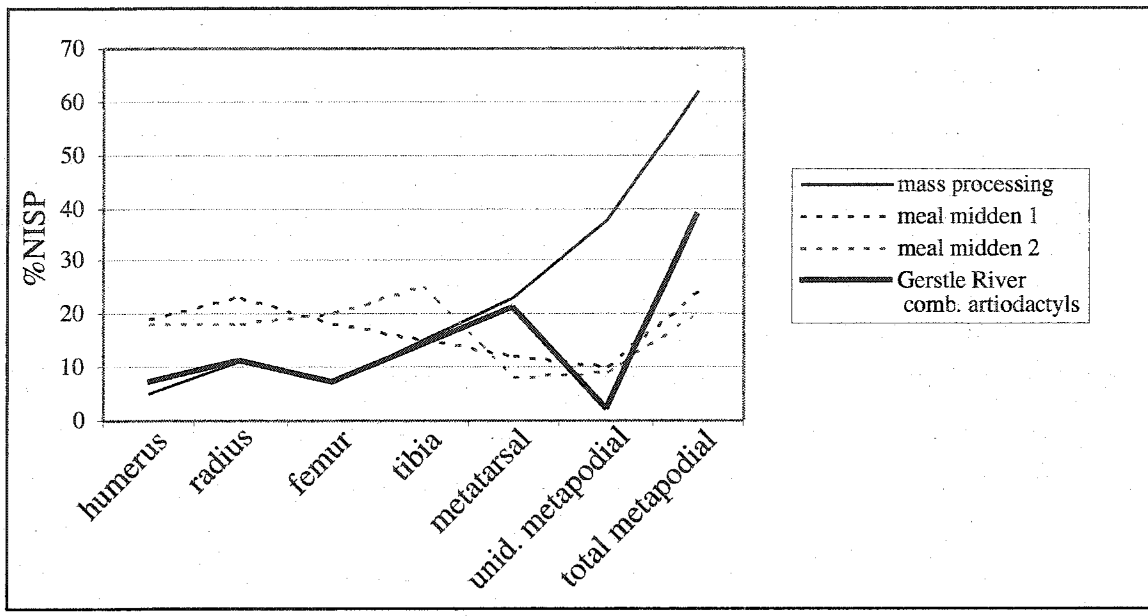


Figure 6.46 Long bone %NISP for mass processing and consumptive marrow extraction strategies (data from Enloe 1993a:Table 5-2, derived from Binford 1978)

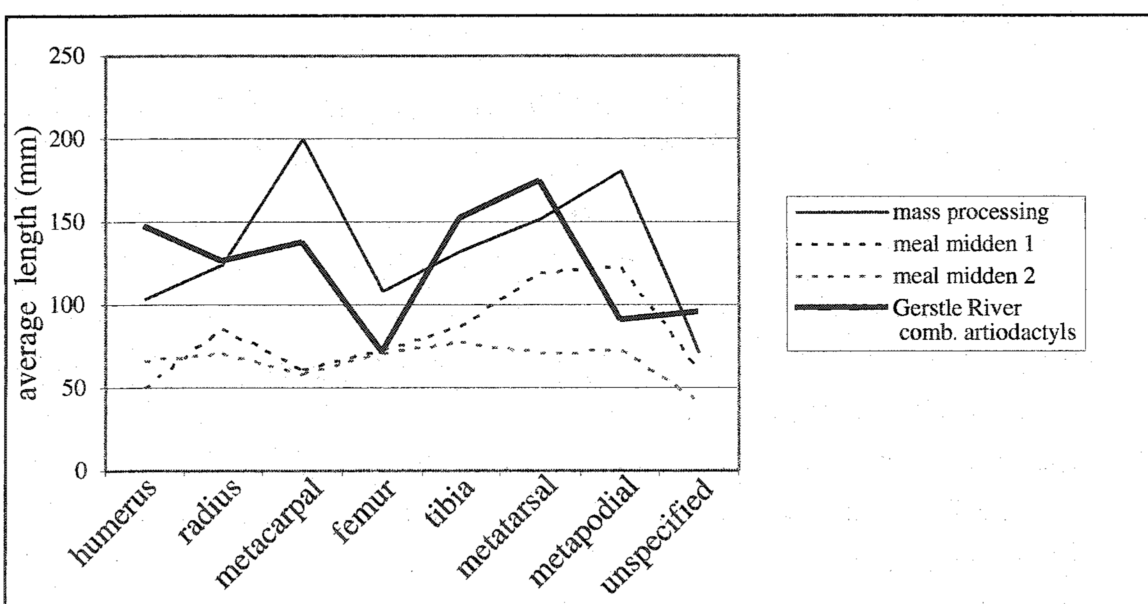


Figure 6.47 Long bone average length (mm) for mass processing and consumptive marrow extraction strategies (data from Enloe 1993a: Table 5-3, derived from Binford 1978)

water in order to render the bone fragments for their grease suggests that bones were not rendered for their grease content at Gerstle River Component 3.

Jodry and Stanford (1992:154) observe that "no evidence of bone greasing has yet been reported...for the Paleoindian time period, in general, on the plains." Stone heating pits and stone boiling pits are common in Late Prehistoric bison kill sites on the plains in association with inferred bison bone grease rendering at sites like Head-Smashed-In (Brink and Dawe 1989) and Bugas-Holding (Todd and Rapson 1988) but are absent at Paleoindian sites (Todd 1991). To date, no evidence of bone grease processing has been found in Alaska during the same period (12,000-8,000 BP).

Models of Economy and Site Function

The patterning of faunal elements with respect to taxonomic abundance and diversity, skeletal element abundance, burning, size, fragmentation, articulation, and spatial distribution within Gerstle River Component 3 can be used to address issues of economic strategies, mobility, and site function. The faunal data are integrated with lithic and other data in Chapters 10 and 11; only the former are used to develop inferences about these issues.

Number and Duration of Kill/Transport/Processing Events

The number of faunal processing events reflected in the faunal assemblage is difficult to estimate. Each faunal cluster had an MNI of 2, and F5 and F7 had an MNI of 3. The similarities in MNI values for each cluster (between 25-38% of total component MNI) suggests that around three kill/transport events took place in this component. These scenarios are supported by the evidence for contemporaneity described in Chapters 4, 5, and 9. As each main lithic subarea appears to be internally coherent and relatively undisturbed (i.e., contemporaneous), the faunal clusters associated with these areas may also be considered contemporaneous. Evidence for one kill or transport event includes the relatively limited spatial distribution of maxillae, which has the highest MNE values for wapiti. These maxillae are located within an area of 10 by 3 meters within Area B. No maxillae are found in Areas A, C, or D. Two explanations could account for this pattern, (1) a series of site occupations where site occupants processed faunal remains in similar ways, or (2) only one relatively short term occupation (a few days or weeks). The data would seem to support the first hypothesis, given the total number of animals represented (N=8).

The similarity in MNI values also could suggest that each faunal cluster associated with a lithic/feature area represents a similar type of faunal processing activity. It is important to note that the two areas associated with individual hearths (cluster F1 and F3) were associated with two animals (one bison and one wapiti at each area), suggesting that multiple animals were processed at the same time or within a relatively short time interval. Only clusters F5 and F7 contained more than two individuals, suggesting that these areas may have functioned the same way for more than one processing event, as a staging area and disposal area respectively.

A number of datasets may reflect how many kill/transport/processing events and occupations took place at Gerstle River Component 3. While it is recognized that occupations may not be dependent on faunal processing and other tasks may have taken place not related to faunal processing, the two are considered equivalent for this analysis. Analysis of occupation number and size considering lithic concentrations, tool distributions, feature distributions, and other data is examined in Chapters 10 and 11. A small number of alternatives may be proposed. There could have been eight occupations (processing events), based on each animal minimally represented in the assemblage. There could have been two or three occupations, based on MNI per faunal cluster. Finally, there could have been one occupation, based on the spatial integrity of the lithic concentrations and faunal remains.

The clear discrimination of lithic and faunal clusters and their relative lack of spatial distortion suggest that several processing events did not occur. Even with similar uses of certain areas for certain tasks (butchering, marrow processing, disposal), the accumulation is not substantial or midden-like. With several events, a more palimpset-like pattern may be expected; however, this was not observed. The close proximity of elements from two to three individuals within all spatial clusters suggests fewer occupations. The integrity of the feature and lithic concentrations suggests that trampling likely to occur if several occupations utilized the same area was minimal.

A single occupation composed of multiple processing events in close association in time is possible, but is considered unlikely for a number of reasons. First, the relatively large number of animals represented by the faunal assemblage were not likely killed at the same time at a place close enough to the site where low yield elements were brought to the site. There is no direct evidence of large-scale communal hunting in the Late Pleistocene / Early Holocene record in Interior Alaska (e.g., fences, corrals, or bone beds).

After rejecting scenarios of several occupations or a single occupation on the basis of site spatial integrity and numbers of animals represented in the faunal assemblage, two or three occupations can be evaluated. Two or three occupations are consistent with the intracluster MNI estimates for all clusters. Spatially disentangling these components will be difficult if not impossible given the limited distribution of refits, the generally tiny flake sizes resulting from tool maintenance, and lack of early core or biface reduction. Lithic material distributions may provide a key in assessing individual flaking episodes. In addition, identifying patterns in association of certain lithic tool types and faunal clusters may elucidate occupation distribution in space and functional relationships between these datasets.

Occupation duration can be crudely estimated from a variety of datasets, from number and size of hearths, number of debitage, faunal remains, and spatial patterning of all of the above. From ethnographic studies, numerous factors are known to influence or condition occupation duration, such as season, time of day, hunting strategies, economic strategies, residential mobility, and logistical position on the landscape mitigated by technology and storage (see Binford 1978a; Kelly and Todd 1988; Chatters 1987). No evidence of structures or shelters such as post holes or tent ring stones were observed, and the density of the lithic items does not suggest intensive or extended occupation of the site. The accumulation of faunal debris was not patterned or concentrated in a way to suggest household midden accumulations. On the basis of the faunal remains alone, assuming two to three kill/transport events, then an estimate of between a few hours to three days per event is reasonable.

The faunal remains selectively culled from the site include element portions associated with high meat yields, including thoracic and cervical vertebrae, ribs, and to a lesser extent, upper limbs. This pattern reflects transportation of high utility portions. Given that almost no fragments of these elements were present in the assemblage, this indicates that either (a) there were limits to number or amount of animal portions that could be removed due to small group size, or (b) the settlement pattern was characterized with high residential mobility and the hunting strategies were efficient and generally successful, resulting in "high-grading" the available portions for consumption at other locations, perhaps at a residential base camp (see Chapters 10 and 11). The second alternative is more consistent with the data given lithic analyses and spatial analyses presented in Chapters 7, 8, 10, and 11.

Non-Food Resources

A number of the analyses conducted in this chapter have been based on the assumption that only food resources were utilized from the wapiti and bison. The absence of antler, horn, or other worked wapiti or bison specimens, when coupled with the rarity of organic tools (with the exception of the worked mammoth ivory rod or point), suggests the manufacture or maintenance of organic tools were not a major part of the activities that took place on site. It is possible, however, that some of the unidentifiable fragments could have been shaped; but given the generally poor condition of the outer cortex of the bone, it will be difficult to investigate bone modification. Sinew could be useful for many clothing and tool-related products (Perkins and Daly 1968), but the data is insufficient to infer clothing manufacture at the site. Overall, selection of skeletal parts for manufacturing artifacts and structural use of bones do not appear to be reflected in the skeletal part frequencies, fragmentation patterns, and spatial distribution patterns. A number of hypotheses can be offered to explain the patterns with respect to antler use (if they were used): the antlers could have been used in tool manufacture earlier at the kill site(s) or later at a residential base camp.

Bones can be used as fuel sources, and some have suggested that if wood were a limiting factor in the colonization of the Subarctic and Arctic regions other fuel sources such as bone or could be used (Guthrie 1990; Hoffecker et al. 1993; Bigelow 1997). The burned bones were closely correlated with hearth areas, however the presence of various woods as fuel, the high charcoal content of the hearths (see Chapter 9), and the presence of numerous unburned bones suggests that bone was not used as an exclusive or major fuel source. The overall correlation of the hearths and burned bone distribution suggests that bones were not burned and then subsequently removed from the hearths and discarded elsewhere. The burning of some bones may be related to accidental introduction of bones that were being processed around the fire into the fire or alternately that bones after marrow was extracted were dumped into the fires to further fuel them.

Intersite Comparisons

Gerstle River Component 3 faunal assemblage data can be incorporated with other data to examine broader issues of subsistence in the Late Pleistocene and Early Holocene. This section compares the Gerstle River data to other assemblages in Interior Alaska and inferences are made regarding taxonomic abundance and archaeological diet breadth. Large-bodied ungulates, especially wapiti and bison, have been key subsistence resources in the Paleolithic of the Old World and the New Worlds. Exploitation of wapiti (red deer) in Europe and Asia has been documented in detail from the Middle and Upper Paleolithic, where it dominates faunal assemblages (Pike-Tay 1991; Steele 2002). On the other hand, bison played a key role in early Paleoindian economies in the New World. While some have questioned early Paleoindian reliance on bison and other large mammals (Meltzer 1993; Grayson and Meltzer 2002; Cannon and Meltzer 2004), other studies have shown a clear pattern of specialized large mammal hunting during the Late Pleistocene and Early Holocene in North America (Waguespack and Surovell 2003; Haynes 2002; Hofman and Todd 2001; see also Kelly and Todd 1988; Frison 1998).

Evaluating taxonomic abundance and archaeological diet breadth requires data from faunal assemblages from archaeological contexts within the time period of concern. Only eleven archaeological components (besides those at Gerstle River) have associated fauna identifiable to taxon in Interior Alaska from 12000-7000 BP. These archaeological faunal assemblages are listed in descending order of associated radiocarbon dates.

Swan Point CZ4 (~12100 BP) contains mammoth (dated to the occupation), large ungulates (likely cervid) and birds, including goose (*Branta* sp.) (Holmes et al. 1996:321; Holmes 2004, personal communication). Broken Mammoth CZ4 (~11500 BP) contains 60% bird (of total NISP), 25% large mammal, and 15% small mammal. Avians include swan (*Cygnus columbianus*) (70% of waterfowl NISP), geese (*Branta* sp., *Anser* sp.) (20%), dabbling ducks (*Anas* sp.) (10%), and willow ptarmigan (*Lagopus lagopus*), large mammals include wapiti (65% of large mammal NISP), bison (35%), and mammoth tusk fragments, some dating to the occupation, small mammals include ground squirrel (*Spermophilus* parryi), hare (*Lepus arcticus*), and hoary marmot (*Marmota caligata*), and carnivores include arctic fox (*Alopex lagopus*) and dire wolf (*Canis dirus*) (Yesner 1996:265). Mead CZ4 (~11,500 BP) contains bison, wapiti, and birds (Holmes, 1999 personal communication). Dry Creek C1 (~11100 BP) contains wapiti and sheep (*Ovis dalli*) (Guthrie 1983a).

Broken Mammoth CZ3 (~10300 BP) contains 60% large mammals (of total NISP), 30% small mammals, 10% waterfowl, and a few salmonid fish specimens. Large mammals include bison (50% of large mammal NISP), wapiti (35%), caribou (*Rangifer tarandus*) (15%), dall sheep (1 specimen), wolf (1 specimen), and mammoth tusk fragments and small mammals include ground squirrel, rodents (shrews, collared pika, voles), hare, hoary marmot, and otter (*Lutra canadensis*) (Yesner 1996:264-265; Holmes 1996; Yesner 1994). Additionally, a moose (*Alces alces*) specimen was found in CZ3 in 1998 (Yesner 2000). Swan Point CZ 3 (~10200 BP) contains waterfowl (goose and ptarmigan), wapiti, and possible bison (Holmes 2004, personal communication). Dry Creek Component 2 (~10000 BP) contains bison, sheep, and gastroliths (which may relate to ptarmigan-sized birds) (Guthrie 1983a). Healy Lake Chindadn (~9500 BP) contains small mammal (rabbit/squirrel sized), birds, and large mammals (caribou/sheep size) (Cook 1996). Carlo Creek C1 (~8500 BP) contains caribou, sheep, and ground squirrel (*Citellus* sp.) (Bowers 1980). Broken Mammoth CZ2 (~7600 BP) contains bison, moose, caribou, beaver (*Castor canadensis*), hare, ground squirrel, small rodents, and unidentified birds (Holmes 1996). Swan Point CZ2 (~7400 BP) contains moose.

The Broken Mammoth CZ4 and CZ3 faunal assemblages have been partially described, and Yesner describes taxonomic diversity in terms of percent of total NISP (1996:264-265). Gerstle River Component 3 is more similar to Broken Mammoth CZ4 in terms of large mammal abundance (69% wapiti, 31% bison vs. 65% wapiti, 35% bison respectively), but no avian remains were found at the former. While the sample size is small, there does seem to be a decline in avian exploitation with 60% of NISP at Broken Mammoth CZ4 (~11500 BP), 10% at Broken Mammoth CZ3 (~10300 BP), and none at Gerstle River Component 3 (~8900 BP). Gerstle River Component 1 (~9700 BP) does contain five avian (?) skeletal fragments (14% of total faunal weight, see below).

Evidence of broad spectrum foraging, or a generalized economy, such as presence of small mammals, birds, or fish, is not present at Gerstle River Component 3. Though the sample sizes are small, Gerstle River Component 3 mortality profiles for wapiti suggest a prime dominated mixed sex profile for wapiti and prime-juvenile female profile for bison. The relative absence of juvenile individuals suggests rather robust hunting strategies, in terms of efficiency and success. The lack of bone grease rendering and the completeness of a number of bones that could have been cracked for marrow extraction and consumption indicates that nutritional stress was not present. Further speculation on diet breadth of the population as a whole, such as waterfowl or small mammal use is unwarranted given the small sample size. The Gerstle River Component 3 data does suggest that considerable economic variability may exist at the level of seasonal camps with respect to diet breadth. Gerstle River Component 3 is situated within a time period where little is known about subsistence economies. When examined in conjunction with

Broken Mammoth CZ4 (11500 BP) and CZ3 (10300 BP), an increasing trend for less use of waterfowl and increased preferences for large ungulates does seem to be indicated. Bison distribution and age has been amply documented by Stephenson et al. (2001), but wapiti distribution and age has seen relatively little investigation (cf. Guthrie 1966).

There are only seven published, dated assemblages with associated wapiti in Alaska (see Figure 6.48). Five of the seven are in archaeological contexts (the others are Lost Chicken Creek paleontological site, near Eagle and Gerstle River stratum Y2). Gerstle River Component 3 is the latest evidence of wapiti exploitation in Alaska, though a few dated assemblages are known from the Yukon Territory, notably at Pelly Farm (MacNeish 1964). The radiocarbon record for wapiti in Alaska extends to the Gerstle River stratum Y2 assemblage, at between 5050±90 BP and 6239±51 BP (average of two dates, see Chapter 5). The Yukon Territory dates extend to 2920±140 BP (GSC-127) from Pelly Farm (KfVd-2). This pattern suggests that wapiti was present in Interior Alaska through much of the Holocene, and may have played a more important economic role than previously thought.

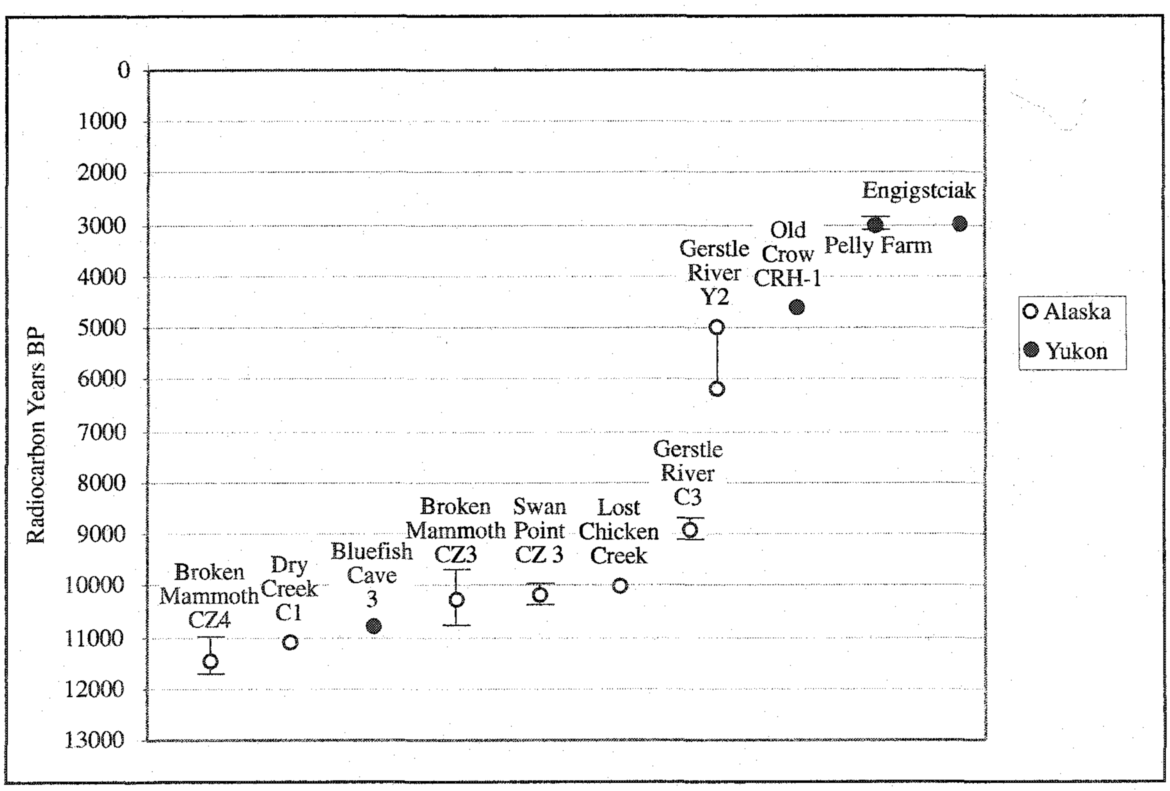


Figure 6.48 All radiocarbon dated assemblages associated with wapiti in Alaska and Yukon Territory.

Other Faunal Assemblages

A number of other faunal assemblages were recovered in various contexts at Gerstle River Lower Locus from 1996-2003. Most of the faunal assemblages are small, ranging from <1% to 4% of the total faunal remains recovered by weight. Table 6.16 lists summary data on all archaeological assemblages and those associated with stratum Y2 and Block W. Average weight per fragment shows that Components 1, 2, 3, and 4, and Block W are generally composed of small fragments compared with Component 5 and stratum Y2 (0.2-4.4 g vs. 11.7-33.0 g). This may suggest different utilization of Component 5 fauna, or perhaps suggest that those remains from strata Y2 and Y3 not directly associated with Component 5 materials may be non-cultural in origin. None of the Y2 remains were burned, but high percentages of Components 4, 5, and Block W remains were burned, suggesting utilization by humans. Figure 6.49 illustrates maximum and minimum dimensions for all remains for each assemblage. Components 1, 2, and 4 are characterized by relatively small fragments, and the others by larger fragments. %long bone weights are generally similar to Component 3, though Components 1 and 2 have few or no long bones. NISP/n fragments shows two groupings, with Components 1, 2, 3, and 4, and Block W with 0-10 and Component 5 and stratum Y2 with 50-69. This may suggest that stratum Y2 remains are not associated with an archaeological component and that those bones not directly associated with Component 5 in Blocks Y and Z may not be associated with humans as well. Each assemblage is described below.

Table 6.16 Faunal assemblages summary comparison.

Variable	*Comp. 1*	*Comp. 2*	*Comp. 3*	*Comp. 4*	*Comp. 5*	*Strat. Y2*	*Block W*
N fragments	35	10	4224	149	42	29	59
total weight (g)	7.5	1.9	12068.7	82.4	491.6	964.3	257.1
avg. wt./provenience unit	0.3	0.5	15.7	4.8	25.9	68.9	18.4
avg. wt/fragment	0.2	0.2	2.9	1.8	11.7	33.3	4.4
avg. max. dimension (cm)	1.8	0.9	4.5	2.3	4.4	10.5	5.7
avg. min. dimension (cm)	0.3	0.3	0.9	0.5	1.7	2.7	0.7
assemblage density	0.4	0.5	133.4	13.7	32.8	160.7	85.7
%burned wt.	1	5	6	80	41	0	77
%long bone wt.	9	NA	69	54	45	89	52
NISP all taxa	3	1	192	0	21	20	1
NISP/n fragments	9	10	5	0	50	69	2

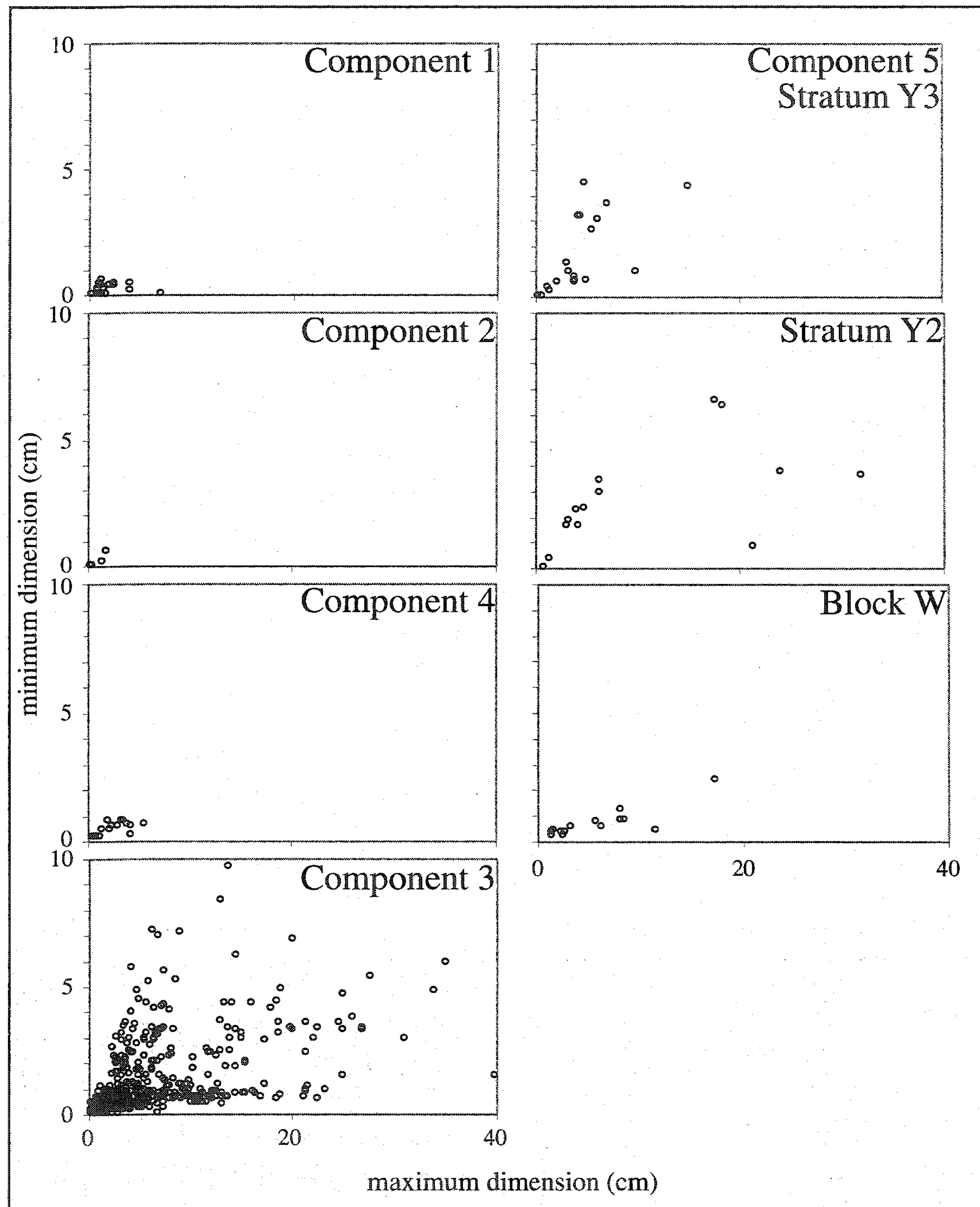


Figure 6.49 Maximum and minimum dimension comparisons of Gerstle River faunal assemblages.

Component 1 Faunal Assemblage

A total of 22 faunal provenience units were collected from Component 1 contexts in 1999-2003. Component 1 is associated with Paleosol 1, and has associated dates of 9893±35 BP (average of three dates). Component 1 faunal remains consisted of 35 fragments and a total weight of 7.5 g. The average weight per provenience unit was 0.3±0.4 g, and ranged from 0.1 g to 1.5 g. The average weight per fragment was 0.2 g, much smaller than the Component 3 faunal assemblage (2.9 g). Three provenience units were identified to skeletal element or skeletal unit type (14% of total by provenience unit, 5% of total by weight), including three mammalian enamel fragments and an avian L acetabulum. No fish remains were found within Component 1. Table 6.17 summarizes the faunal data associated with Component 1. Size class data indicate multiple sizes of animals, small to very large, with the majority of indeterminate size. Besides 5 indeterminate and 5 Aves fragments, the remaining 25 fragments (71% of total weight) are mammals. Only 1% of the remains are burned, though 1 fragment appears reddened. Weathering patterns and bone condition are similar to Component 3, with the majority with root-etching damage (86% by weight). Unidentified bone fragments are the most common faunal shape (85% by weight). Due to weathering, most of the cortical surfaces are deteriorated, and no features such as cut-marks, carnivore gnawing, pitting, or scoring were observed on the Component 1 fauna.

Component 1 maximum dimension averages 1.8±1.6 cm and minimum dimension averages 0.3±0.2 g, significantly smaller than the Component 3 faunal materials. Figure 6.49 compares maximum and minimum dimension (per provenience unit) for all *in situ* Gerstle River faunal assemblages. Component 1 faunal dimensions (measured on largest fragment in each provenience unit) are similar for Components 1, 2, and 4 in fragments under 7 cm in maximum dimension and 1 cm in minimum dimension. Faunal density was calculated as above, as total faunal weight per total area (sum of all 1 m^2 excavation units containing at least one faunal fragment). Assemblage faunal density for Component 1 is 7.5 g/17m^2, or 0.4 g/m^2. Density per square meter ranges from 0.1 to 1.5 g/m^2. A total of 17 m^2 contained faunal remains, 22% of the 77 m^2 total area excavated to Component 1. Faunal density for Component 1 is much lower than that for Component 3 (133.4 g/m^2).

The spatial distribution of the few faunal remains found within Component 1 appear patterned relative to the lithic concentrations. Figure 6.50 shows all faunal fragments (either 3-

pointed or positioned in the center of their respective screened areas, normally 0.25 m^2) and density contours for all Component 1 lithics. The faunal remains are situated at the periphery of the main lithic artifact concentrations to the south and west. Relative to the lithic scatter, the faunal remains are more dispersed.

Interpretation of Component 1 fauna is limited by the low abundance and lack of identifiable specimens.

Table 6.17 Component 1 faunal assemblage summary.

Variable	*N fragments*	*% N fragments*	*Weight (g)*	*%weight*
		Size class		
Indeterminate	24	69	2.5	33
S	2	6	0.2	3
S-M	2	6	0.7	9
M-VL	4	11	3.2	43
VL	3	9	0.9	12
		Taxonomic Class		
Indeterminate	5	14	0.6	8
Aves?	5	14	1.6	21
Mammalia	25	71	5.3	71
		Taxa		
Indeterminate	35	100	7.5	100
		Burning type		
Black charred	1	3	0.1	1
Possibly burned	1	3	0.1	1
Unburned	32	91	6.5	87
Reddened	1	3	0.8	11
		Weathering		
Root-etched	28	80	6.4	86
Indeterminate	7	20	1.1	15
		Faunal shape		
Unidentified	29	83	6.4	85
Long bone	1	3	0.7	9
Teeth/enamel	3	9	0.2	3
Irregular/short	2	6	0.2	3

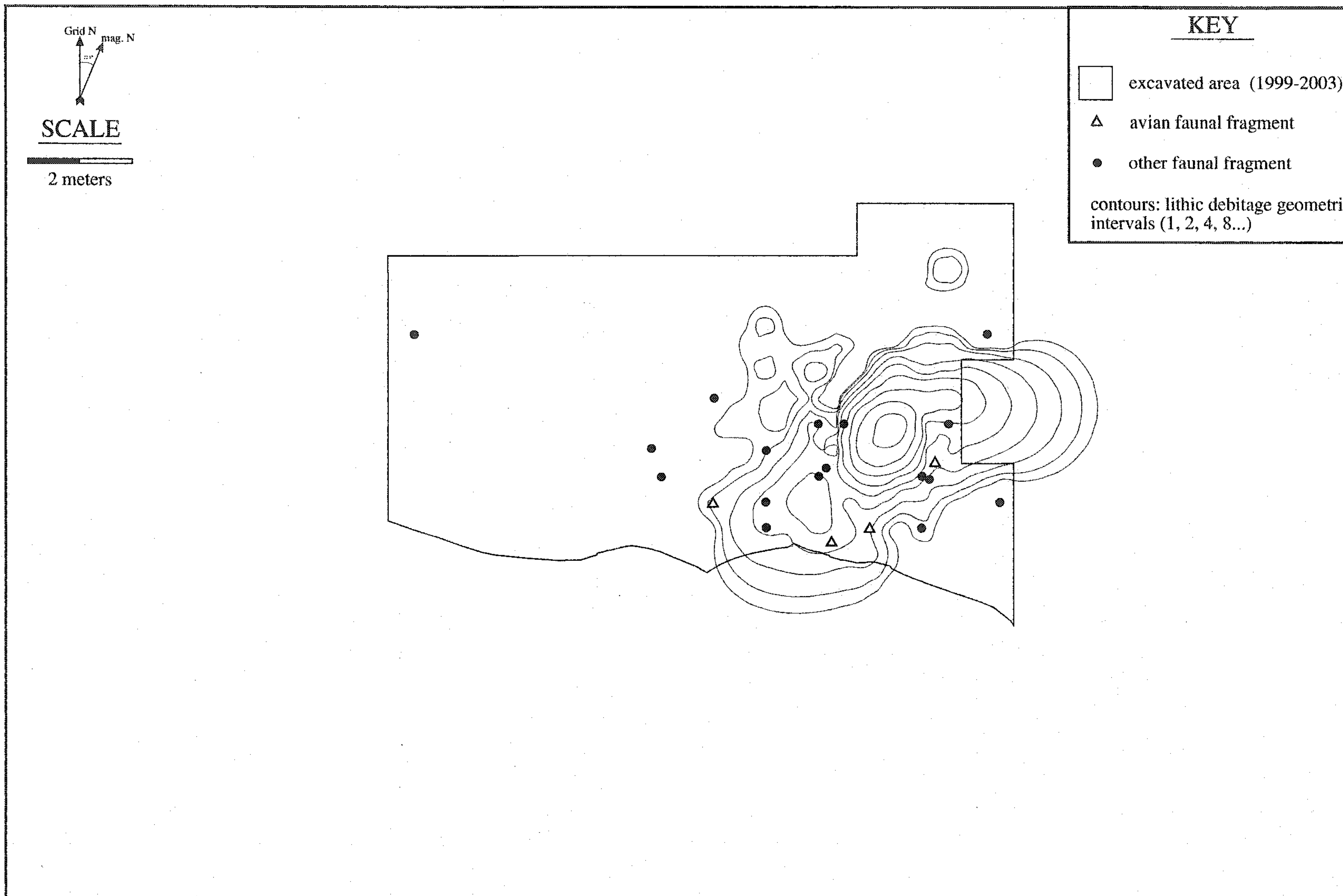


Figure 6.50 Component 1 faunal spatial distribution. Note contours represent overall lithic debitage distribution.

Component 2 Faunal Assemblage

A total of 4 faunal provenience units were collected from Component 2 contexts in 1999-2003. Component 2 is associated with stratum Y4b, and dates to 9449±41 BP (average of two dates). Component 2 faunal remains consisted of 10 fragments and a total weight of 1.9 g. The average weight per provenience unit was 0.5±0.5 g, and ranged from 0.1 g to 1.2 g. The average weight per fragment was 0.2 g, much smaller than Component 3 faunal assemblage. One provenience unit was identified to skeletal element or skeletal unit type (25% of total by provenience unit, 63% of total by weight), consisting of large artiodactyl incisor enamel fragments (n=7 fragments). No fish or avian remains were found in Component 2.

Table 6.18 summarizes the faunal data associated with Component 2. Size class and taxonomic class data indicate that the remains are derived from medium to very large mammals, and likely from very large mammals. One small bone fragment was calcined or bleached, and the remaining faunal remains were unburned. Weathering patterns and bone condition are similar to Component 3, with root-etching damage common (32% by weight). No surface modification was observed on this small assemblage.

Component 2 maximum dimension averages 0.9±0.8 cm and minimum dimension averages 0.3±0.2 g, significantly smaller than the Component 3 faunal materials. Figure 6.49 compares maximum and minimum dimension (per provenience unit) for all *in situ* Gerstle River faunal assemblages. Component 2 faunal dimensions (measured on largest fragment in each provenience unit) are similar to Components 1 and 4, consisting of fragments under 7 cm in maximum dimension and 1 cm in minimum dimension. Assemblage faunal density for Component 1 is 1.9 g/4m^2, or 0.5 g/m^2. Density per square meter ranges from 0.1 to 1.2 g/m^2. A total of 4 m^2 contained faunal remains, 5% of the 86 m^2 total area excavated to Component 2. Faunal density for Component 2 is much lower than that for Component 3 (133.4 g/m^2).

The spatial distribution of the few faunal remains found within Component 2 and stratum Y4b appear widely dispersed across the site relative to the lithic concentrations. Figure 6.51 shows all faunal fragments (either 3-pointed or positioned in the center of their respective screened areas, normally 0.25 m^2) and density contours for all Component 2 lithic artifacts. Three of the four provenience units were located near the two activity areas (Areas E and F), and the fourth (consisting of fine bone particles) were found in block R. The faunal remains are situated at the periphery of the lithic artifact concentrations of Area E and F.

Four bison specimens from disturbed contexts and one bison specimen from Component 3 were sampled for DNA analysis by Beth Shapiro at Oxford University, Department of Zoology in 2000. Two specimens from disturbed contexts were radiocarbon dated, UA97-61-229, bison R metatarsal yielding a date of 9400±60 BP (OxA-11246), UA97-61-231 bison R metatarsal yielding a date of 9510±40 BP (OxA-11962). Both were considered *Bison priscus* (steppe bison) according to her analysis (Shapiro 2003, personal communication). Though these remains were from disturbed contexts, the radiocarbon dates are statistically the same as the two radiocarbon dates on Component 2 hearth features (9400±50, β -183110 and 9510±50, β-134098). Following the protocols for testing contemporaneity of radiocarbon dates presented in Chapter 5, the bison dates are statistically the same, T' (χ^2 0.5) = 3.57 (7.81), and average 9457±29 BP. Given these radiocarbon dates and the presence of very large mammal remains including large artiodactyl teeth/enamel, these bison remains could be associated with Component 2. If this is the case, there must have been another cluster of Component 2 material with a different character than two areas already excavated (Areas E and F, see Chapter 10).

Table 6.18 Component 2 faunal assemblage summary.

Variable	*N fragments*	*% N fragments*	*Weight (g)*	*%weight*
		Size class		
Indeterminate	2	20	0.2	11
M-VL	1	10	0.5	26
VL	7	70	1.2	63
		Taxonomic Class		
Mammalia	10	100	1.9	100
		Taxa		
Indeterminate	3	30	0.7	37
unknown Artiodactyl	7	70	1.2	63
		Burning type		
Calcined/bleached?	1	10	0.1	5
Unburned	9	90	1.8	95
		Weathering		
Root-etched	2	20	0.6	32
Indeterminate	8	80	1.3	68
		Bone Type		
Unidentified	3	30	0.7	37
Teeth/enamel	7	70	1.2	63

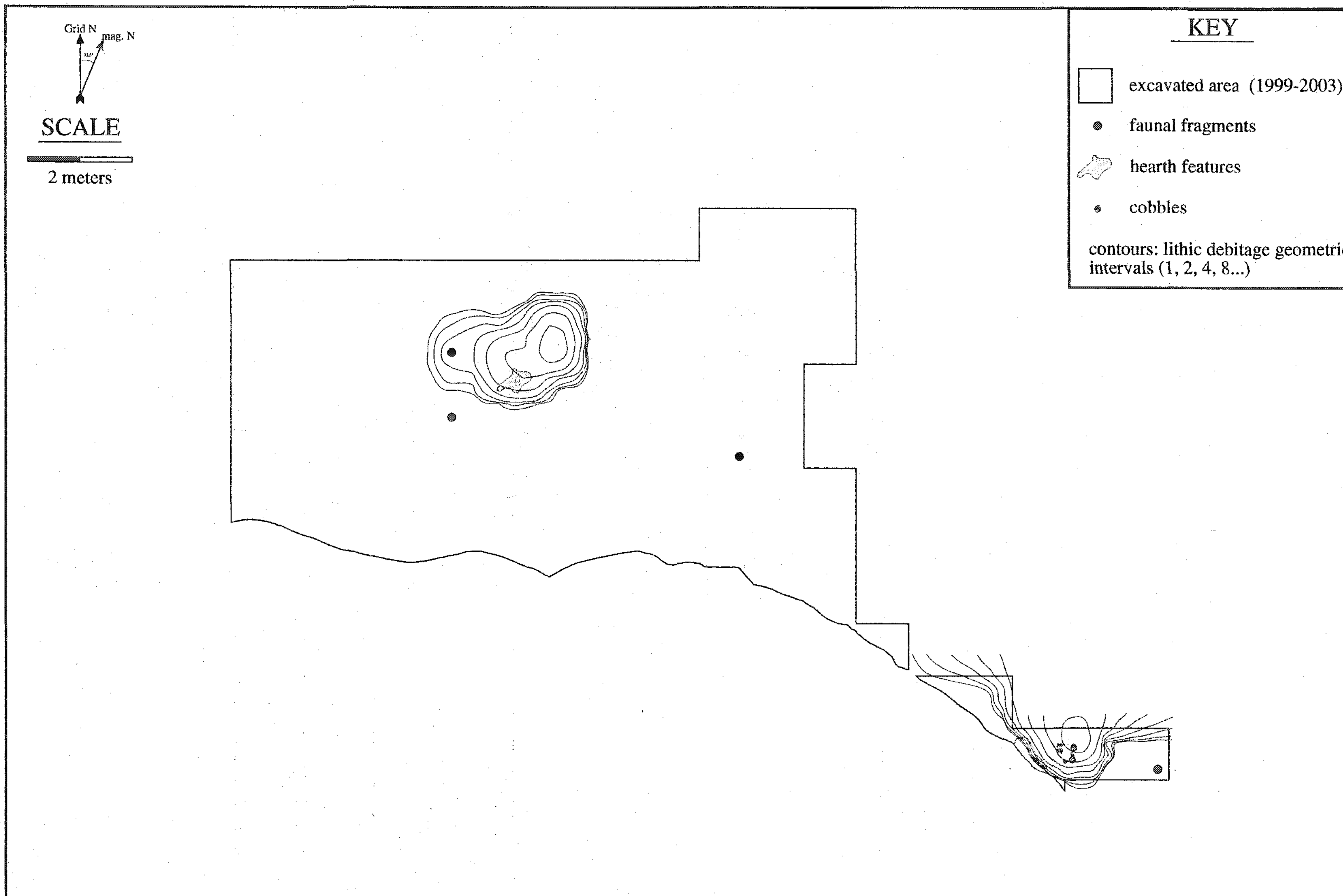


Figure 6.51 Component 2 faunal spatial distribution. Note contours represent overall lithic debitage distribution.

Component 4 Faunal Assemblage

A total of 17 faunal provenience units were collected from Component 4 contexts in 1999-2003. Component 4 is associated with stratum Y4a, and dates to 8660±40 BP (see Chapter 5). Component 4 faunal remains consisted of 149 fragments and a total weight of 82.4 g. The average weight per provenience unit was 4.8±7.2 g, and ranged from 0.1 g to 22.4 g. The average weight per fragment was 1.8 g, similar to the Component 3 average weight (2.9 g). No fragments were identified to skeletal element or skeletal unit type. No avian or fish remains were found within Component 4; all fragments were considered mammals.

Table 6.19 summarizes the faunal data associated with Component 4. Size class data indicates generally large to very large mammals were present (87% by weight). The majority of the faunal remains were burned (80% by weight), and 22.4 g were found within hearth Feature 7 (27% by weight). Weathering patterns and bone condition are similar to Component 3, with the majority with root-etching damage (76% by weight), though a moderate percentage exhibited surface flaking/exfoliation (28%). In terms of faunal shape, long bones (54% by weight, 41% by number of fragments) predominate, comparable with Component 3, which had similar percentage of long bones (69% by weight). No cut-marks, carnivore, gnawing, pitting, or scoring were observed on the Component 4 fauna. Given the general similarities in faunal shape, size class, taxonomic class, and the close association with Feature 7, the Component 4 faunal remains appear very similar to those within Component 3 faunal clusters associated with hearth features and lithic concentrations.

Component 4 maximum dimension averages 2.3±1.6 cm and minimum dimension averages 0.5±0.2 cm, slightly smaller than Component 3 (maximum dimension average 4.5±5.5 cm, minimum dimension average 0.9±1.2 cm). Figure 6.49 compares maximum and minimum dimension (per provenience unit) for Component 4 and other assemblages. Component 4 faunal dimensions are similar with Components 1 and 2 in fragments under 7 cm in maximum dimension and 1 cm in minimum dimension. Assemblage faunal density for Component 4 is 84.2 $g/6m^2$, or 13.7 g/m^2. Density per square meter ranges from 0.6 g/m^2 to 62.8 g/m^2. A total of 6 m^2 contained faunal remains, 6% of the 107 m^2 total area excavated to Component 4. Faunal density for Component 4 is intermediate between that of Component 3 (133.4 g/m^2) and Components 1 and 2 (0.4 and 0.5 respectively) and similar to that of Component 5 (32.8 g/m^2).

The spatial distribution of faunal remains within Component 4 shows a tight concentration around hearth Feature 7 in Area G (Figure 6.52), about 1 m north of a debitage concentration. No faunal remains were recovered near the other Component 4 lithic concentration, Area H. The comparison of Component 3 marrow processing features (Features 1, 3, 5, 10, 12, and 14) with Feature 7 faunal remains suggests a similar function for the latter (see Chapter 9).

Table 6.19 Component 4 faunal assemblage summary.

Variable	*N fragments*	*% N fragments*	*Weight (g)*	*%weight*
		Size class		
Indeterminate	12	8	0.8	1
M-VL	3	2	10.0	12
L-VL	125	84	49.3	60
VL	9	6	22.3	27
		Taxonomic Class		
Mammalia	149	100	82.4	100
		Taxa		
Indeterminate	149	100	82.4	100
		Burning type		
Calcined	5	3	0.4	1
Calcined, black charred	121	81	64.9	79
Possibly burned	2	1	9.4	11
Unburned	21	14	7.7	9
		Weathering		
Root-etched	120	81	62.3	76
Surface flaking	9	6	23.3	28
Indeterminate	20	13	12.1	15
		Faunal shape		
Unidentified	88	59	37.6	46
Long bone	61	41	44.8	54

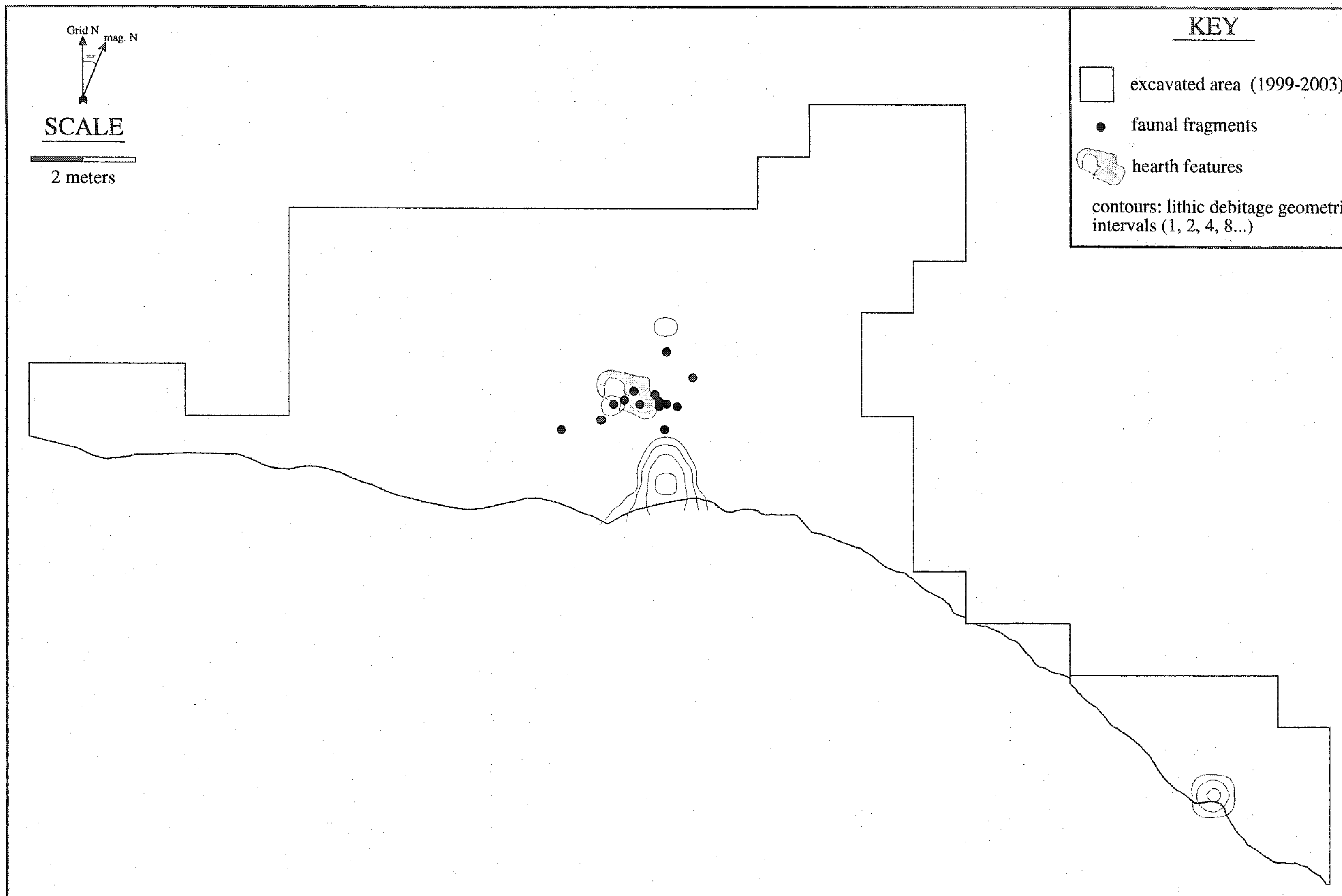


Figure 6.52 Component 4 faunal spatial distribution. Note contours represent overall lithic debitage distribution.

Component 5, Stratum Y3 Faunal Assemblage

A total of 19 faunal provenience units were collected from Component 5 or stratum Y3 contexts in 1999-2003, including a *Cervus elaphus* innominate fragment found about 1 m below the Bluff Test Pit surface (Holmes 1998a:10), removed by Holmes some weeks prior to the 1996 excavation of the bluff test pit (Vanderhoek 1996: field notes). This specimen was not part of the 1996 collection delivered to the author, and is therefore not examined in this analysis. Component 5 is associated with stratum Y3, and dates to between 7600±140 BP and 8337±43 BP (average of two dates, see Chapter 5).

Component 5 faunal remains consisted of 42 fragments and a total weight of 491.6 g. The average weight per provenience unit was 25.9±51.9 g, and ranged from 0.1 to 203.2 g. The average weight per fragment was 11.7 g, the highest by far for any assemblage at Gerstle River. Ten provenience units were identified to skeletal element or skeletal unit type (53% by provenience unit, 95% by weight), including wapiti R 2nd phalanx, R 2nd phalanx, atlas, distal humerus, mandibular deciduous P4, bear 2 intermediate phalanges, and L pes (including metatarsals 1, 2, 3, 4, 5 and 6 tarsals, see Figure 6.54). Total wapiti NISP is 5, with a MNE of 5, total bear NISP is 13, with an MNE of 13. Other identifiable specimens include small-medium mammal phalanx, VL artiodactyl 1st phalanx, and VL mammal zygapophyse portion of a vertebra. Total NISP for Component 5 is 21. Total wapiti MNI is 1 and total bear MNI is 1. No avian or fish remains were found within Component 5.

Table 6.20 summarizes the fauna data in Component 5. Size class data indicates multiple sizes of animals, from small to very large, though the majority of fauna belong to the very large size class (85% by weight). *Cervus elaphus* remains constitute 17% of the assemblage by number of fragments and 79% by weight. *Ursus* sp. remains constitute 55% of the assemblage by number of fragments and 12% by weight. One mid-diaphysis long bone fragment appears to be Aves. The majority of the bones are unburned (88% by number of fragments, 54% by weight), though two elements are considered brown charred (5% by number of fragments, 41% by weight). Weathering patterns and bone condition are similar to Component 3, with the majority with root-etching damage (54% by weight), though longitudinal cracking was common (7% of fragments and 44% of weight). No surface modification features such as cut-marks, carnivore gnawing, pitting, or scoring were observed on the Component 5 fauna. In terms of faunal shape, relatively few of the faunal fragments were unidentified (17% by fragments and 3% by weight), and irregular/short bone (51% by weight) and long bones (45% by weight) dominate the assemblage.

Component 5 maximum dimension averages 4.4±3.5 cm, and minimum dimension averages 1.7±1.5 cm, about the same size as Component 3 fauna (Figure 6.49). Component 5 faunal dimensions are considerably larger than those for Components 1, 2, and 4. Assemblage faunal density for Component 5 is 491.6 g/15 m^2, or 32.8 g/m^2. Faunal remains were typically found with one provenience unit per m^2, and N48E47 is the only excavation unit with more than two provenience units. Density per square meter ranges from 0.1 to 206.8 g/m^2. A total of 15 m^2 contained faunal remains, 14% of the 107 m^2 total area excavated to Component 5. Faunal density for Component 5 is intermediate between that of Component 3 (133.4 g/m^2) and Components 1 and 2 (0.4 and 0.5 respectively) and similar to that of Component 4 (13.7 g/m^2).

The spatial distribution of the faunal remains found within Component 5 indicates widely dispersed fragments, with very little correlation with the overall lithic distribution (Figure 6.53). Given this patterning, it is unclear based on present data to what extent these faunal remains associated with stratum Y3, especially bear specimens, are associated with Component 5. Six fragments (14% of total fragments, 20.6 g) were recovered in direct association with lithic remains in Area J, including an wapiti 2nd phalanx. This association supports the linkage of wapiti remains from stratum Y3 with Component 5 artifacts. The lack of lithic artifacts associated with the remaining 36 fragments (86% of total fragments, 471.0 g) could indicate differential spatial use of the site with respect to lithic maintenance and faunal processing areas.

Table 6.20 Component 5 faunal assemblage summary.

Variable	*N fragments*	*% N fragments*	*Weight (g)*	*%weight*
		Size class		
Indeterminate	2	5	0.2	0
S-M	2	5	8.4	2
L	23	55	61.2	12
M-VL	3	7	3.1	1
VL	12	29	418.7	85
		Taxonomic Class		
Indeterminate	2	5	0.2	0
Aves?	1	2	8.3	2
Mammalia	39	93	483.1	98
		Taxa		
Indeterminate	12	29	43.6	9
Cervus elaphus	7	17	386.8	79
Ursus sp.	23	55	61.2	12
		Burning type		
Brown charred	2	5	203.2	41
Unburned	37	88	265.9	54
Reddened	3	7	22.5	5
		Weathering		
Longitudinal cracking	3	7	215.0	44
Root etching	33	79	264.4	54
Indeterminate	5	12	3.9	1
Surface flaking, root-etching	1	2	8.3	2
		Faunal shape		
Unidentified	7	17	12.5	3
Long bone	5	12	222.4	45
Teeth/enamel	2	5	3.6	1
Irregular/short bone	28	67	253.1	51

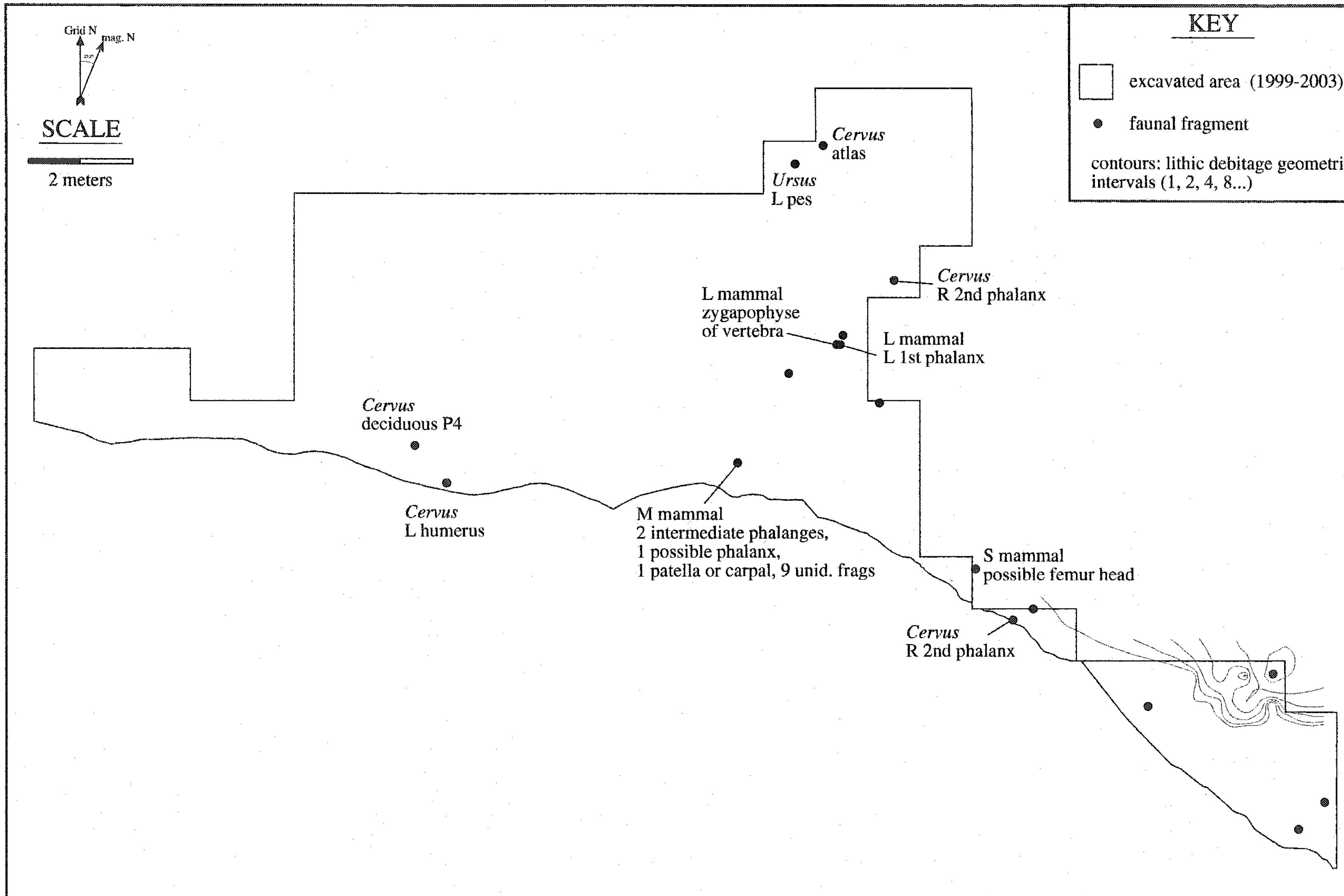


Figure 6.53 Component 5 faunal spatial distribution. Note contours represent overall lithic debitage distribution.

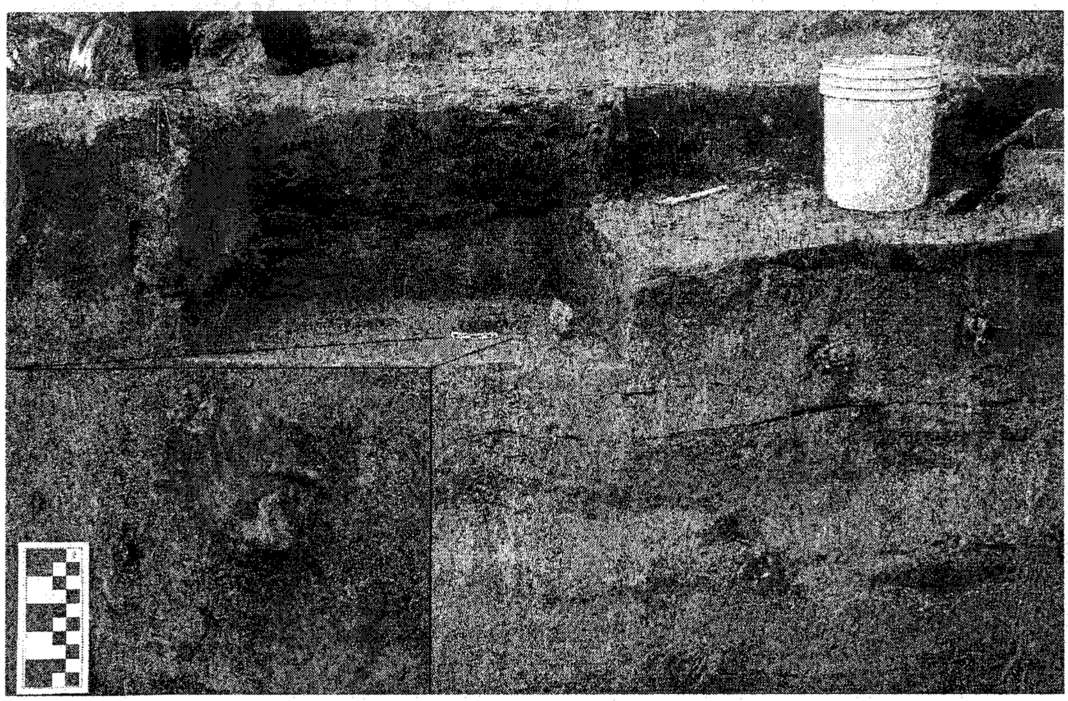


Figure 6.54 Articulated *Ursus* sp. L pes *in situ* (2002).

Stratum Y2 Faunal Assemblage

A total of 14 faunal provenience units were collected within stratum Y2 in 2001-2003, including two provenience units from the 1996 bluff test pit. Stratum Y2 likely dates between 5050±90 BP and 6239±51 BP (average of two dates, see Chapter 5), averaging 5911±48 BP. Stratum Y2 faunal remains consisted of 29 fragments and a total weight of 964.3 g. In addition, an wapiti R complete metatarsal and L 2nd phalanx were observed in April 2003, but were removed from the site between April and May 19, 2003 by unknown parties. These specimens are plotted in Figure 6.49, but are not included in the totals in Table 6.21. The average weight per provenience unit was 68.9±108.8 g, and ranged from 0.1 to 352.2 g. The average weight per fragment was 33.3 g, the highest of all Gerstle River faunal assemblages. Twelve provenience units were identified to skeletal element or skeletal unit type (86% by provenience unit, 99% by weight). Wapiti specimens consisted of R distal humerus, L distal humerus, L radius, L ulna, L scaphoid, L 2nd-3rd carpal, R 1st phalanx, R 2nd phalanx, L 1st phalanx, L cuneiform, two proximal sesamoids, and an enamel fragment (and a complete L metacarpal and L 2nd phalanx mentioned above). A single bear R fibula was found in the 1996 bluff test pit. Total wapiti NISP is 19 with a

MNE of 13 and total bear NISP is 1 with a MNE of 1. Total wapiti MNI is 1 and total bear MNI is 1. No avian or fish remains were found within stratum Y2.

Table 6.21 summarizes the faunal data in stratum Y2. Size class data indicates primarily large or very large mammals. *Cervus elaphus* remains constitute 59% of the assemblage by number of fragments and 98% by weight. *Ursus* sp. remains constitute 3% of the assemblage by number of fragments and 2% by weight. All of the bones are unburned and weathering pattern and bone condition are similar to Component 3, with root-etching damage (100% by weight) and longitudinal cracking (39% by weight) common. The cortical bone condition was generally less deteriorated than most Component 3 specimens. No surface modification features such as cut-marks, carnivore gnawing, pitting, or scoring were observed on the stratum Y2 fauna. This assemblage is dominated by long bones (89% by weight) and irregular/short bones (11% by weight).

Stratum Y2 faunal maximum dimension averages 10.5±10.0 cm, and minimum dimension averages 2.7±2.0 cm, larger than Component 3 fauna (Figure 6.49). Stratum Y2 faunal dimensions are considerably larger than those for Components 1, 2, and 4. Assemblage faunal density for stratum Y3 is 964.3 g/6 m^2, or 160.7 g/m^2. Density per square meter ranges from 0.6 to 643.7 g/m^2. A total of 6 m^2 contained faunal remains, 6% of the 109 m^2 total area excavated to stratum Y2. Faunal density for stratum Y2 is the highest by far among the Gerstle River faunal assemblages (Table 6.16).

The spatial distribution of the faunal remains within stratum Y2 indicates a dense concentration of wapiti remains, possibly from a single partially disarticulated skeleton (Figure 6.55). The spatial position of a nearly complete L limb, from humerus to phalanges in close association or articulation suggests a natural kill. None of the bones were burned or visibly modified by humans, and no cultural materials were found within this layer across the site. The presence within a locally discrete circumscribed area suggests a non-cultural origin for the faunal remains. However, this stratum is associated with a cultural component at the Upper Locus, 60 m distant (Component 6), therefore association cannot be ruled out on the basis of existing data. Further excavation to the west of Block V would shed more light on this faunal assemblage.

Table 6.21 Stratum Y2 faunal assemblage summary.

Variable	*N fragments*	*% N fragments*	*Weight (g)*	*%weight*
		Size class		
Indeterminate	8	28	0.6	0
L	1	3	16.1	2
VL	21	72	947.6	98
		Taxonomic Class		
Mammalia	29	100	964.3	100
		Taxa		
Ursus sp.	1	3	16.1	2
Cervus elaphus	17	59	943.4	98
Indeterminate	10	34	4.7	0
		Burning type		
Unburned	29	100	964.3	100
		Weathering		
Root-etched	26	90	588.6	61
Longitudinal cracking, root-etching	2	7	375.6	39
Indeterminate	1	3	0.1	0
		Faunal shape		
Unidentified	8	28	0.6	0
Long bone	10	34	855.4	89
Teeth/enamel	1	3	0.1	0
Irregular/short	10	34	108.2	11

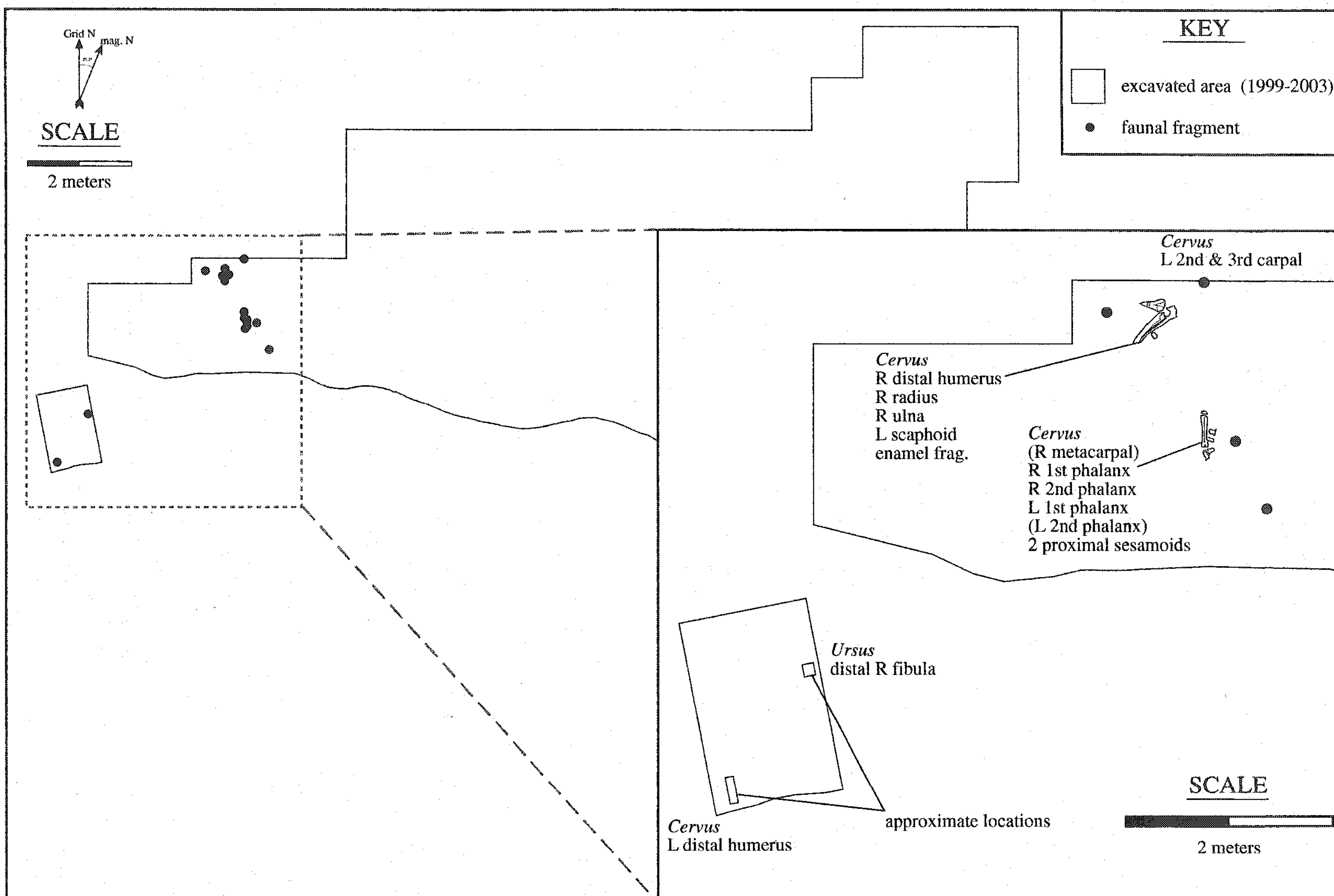


Figure 6.55 Stratum Y2 faunal spatial distribution.

Block W Faunal Assemblage

A total of 14 faunal provenience units were collected from Block W in 2002-2003. After observing faunal remains eroding from the bluff edge and finding *in situ* faunal materials in 2002, a 1 x 2 m^2 excavation block was excavated in 2002. Faunal remains were found about 94-100 cm below the bench surface, situated in a yellow loess about 30 cm above sand. Given the location, it is unclear how the stratigraphy at Block W relates to the main excavation area. The removal of the upper stratigraphy at Block W obfuscates meaningful correlations. The absence of a clear Bw horizon (R4) above the sand suggests that the organic rich silt from which the Block W fauna were recovered may be Paleosol 1. The only means of assessing the position of the faunal remains in Block W is to excavate a trench between Block W and Block V, thus linking the stratigraphy of the two areas. Block W faunal remains consisted of 59 fragments and a total weight of 257.1 g. The average weight per provenience unit was 18.4±52.0 g, and ranged from 0.1 to 198.1 g. The average weight per fragment was 4.4 g, higher than Components 1, 2, 3, and 4, and lower than Component 5 and stratum Y2. One provenience unit was identified to skeletal element (7% by provenience unit, 43% by weight), an wapiti L mandible fragment (Figure 6.57). Additionally, long bone fragments may be an wapiti L proximal metatarsal fragment, though this identification is tentative (Figure 6.58). The wapiti R mandible fragment contains four teeth, deciduous P2, P3, and deciduous 3-cusped P4. The permanent M2 is in the process of erupting, indicating an age of about 1 year old, suggesting that death occurred in summer (Jensen 1999). Total wapiti NISP, MNE, and MNI is 1. No avian, fish, or small-medium mammals were found within Block W.

Table 6.22 summarizes the faunal data in Block W. Size class data indicates only L-VL mammals are represented. *Cervus elaphus* remains constitute 3% of the assemblage by number of fragments and 43% by weight. Most of the bones (by number of fragments) were unburned, but the mandible and long bones (77% by weight) were charred. Weathering patterns are similar to Component 3, all with root-etching damage and 3% with longitudinal cracking; however, the mandible and teeth are in a better overall condition (Figure 6.57). No surface modification features such as cut-marks, carnivore gnawing, pitting, or scoring were observed on the Block W fauna. In terms of faunal shape, long bones (52% by weight) and the mandible fragment (43% by weight) dominate.

Block W fauna maximum dimension averages 5.7±4.6 cm, and minimum dimension averages 0.7±0.6 cm, about the same sizes as Component 3 fauna (Figure 6.56). Block W faunal dimensions are considerably larger than those for Components 1, 2, and 4 and very similar to those for Components 3 and 5. Assemblage faunal density for Block W is 257.1 g/ $3m^2$, or 85.7 g/m^2. Density per square meter ranges from 8.3 to 198.1 g/m^2. Faunal density for Block W is intermediate between Components 1, 2, 4, and 5, and Component 3 and stratum Y2.

No cultural remains (lithics, etc.) were observed in Block W or eroding nearby, and no spatial association can be made between the faunal remains and any cultural remains. However, the presence of the burning and the possible association with Paleosol 1 could suggest the association of these faunal remains with Component 1.

Table 6.22 Block W faunal assemblage summary.

Variable	*N fragments*	*% N fragments*	*Weight (g)*	*%weight*
		Size class		
Indeterminate	20	34	3.3	1
L-VL	11	19	4.7	2
VL	28	47	249.1	97
		Taxonomic Class		
Mammalia	59	100	257.1	100
		Taxa		
Indeterminate	58	97	146.4	57
Cervus elaphus	2	3	110.7	43
		Burning type		
Brown charred	18	31	198.1	77
Possibly burned	9	15	27.9	11
Unburned	32	54	31.1	12
		Weathering		
Root-etched	58	98	248.8	97
Root-etched, longitudinal cracking	1	2	8.3	3
		Faunal shape		
Unidentified	21	36	9.7	4
Long bone	35	59	132.8	52
Flat bone	1	2	3.9	2
Teeth/enamel/mandible	2	3	110.7	43

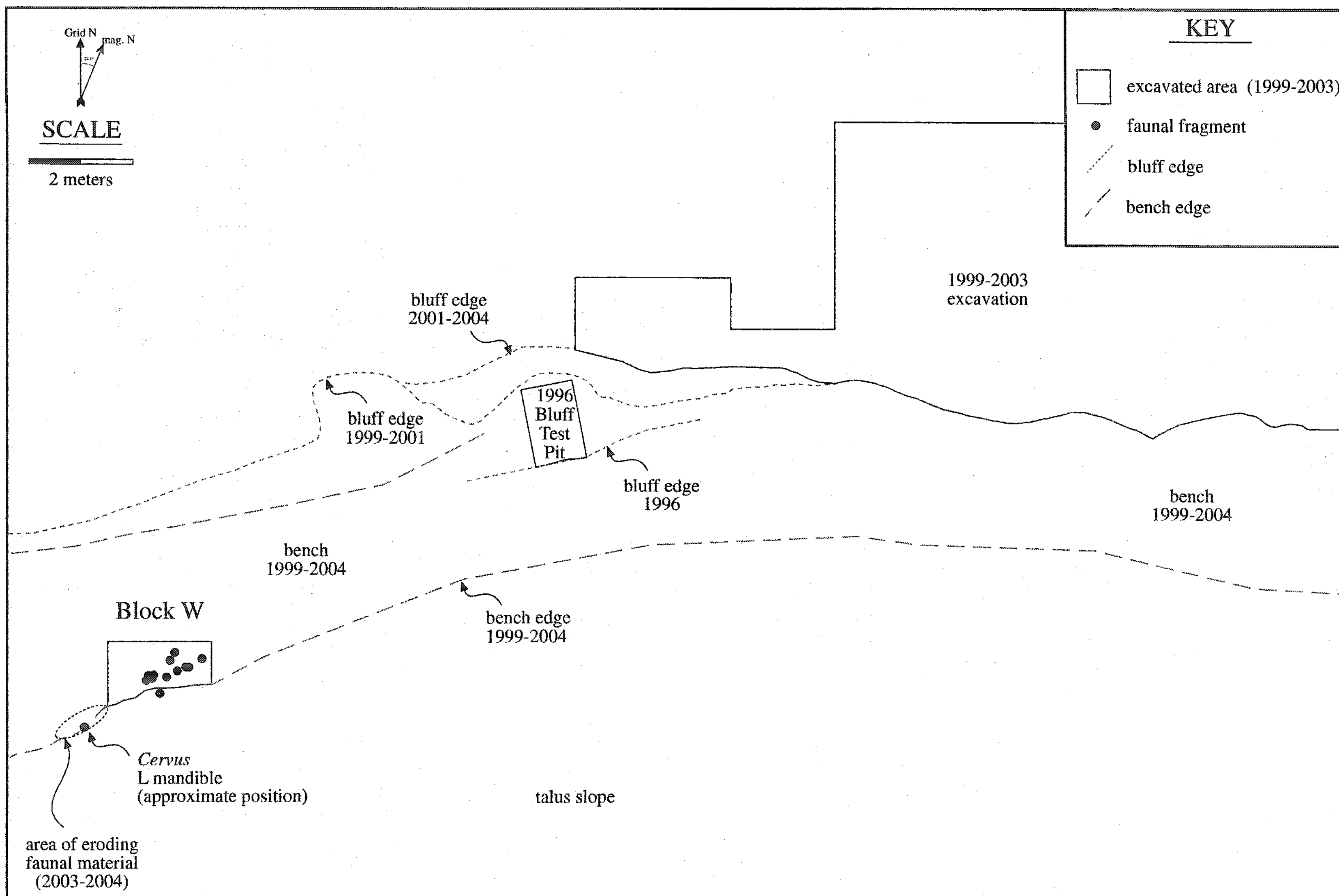


Figure 6.56 Block W faunal location and spatial distribution.

Figure 6.57 Block W wapiti L mandible fragment (UA2002-62-946).

Figure 6.58 Block W burned bones (including possible proximal L metatarsal) (UA2002-62-946).

Subsurface, Non-Cultural Faunal Assemblage

A total of 17 faunal provenience units were collected in subsurface contexts from strata with no associated cultural materials (except stratum Y3 and Block W which are analyzed separately) in 1999-2003. These faunal remains consisted of 63 fragments for a total of 27.6 g. These remains were found in separate stratigraphic contexts and are detailed within stratigraphic groups below. None of these specimens were burned or exhibited human modification.

The first group consists of 9 provenience units (16 fragments, 1.2 g) located between 3.35-4.51 m below site datum associated with Unit III-VII sands, well below any cultural components at the site. All these specimens were recovered from Blocks O, P, Q, and R. Four of the provenience units were three possible egg shell fragments (all <0.1 g) and 8 other unidentified bone fragments (0.3 g) within stratum VIa sand. The remaining five provenience units were associated with Units III-V, lower gray sands, including three possible egg shell fragments (all <0.1 g) and an unidentified bone fragment (0.2 g) dated to 11,980±120 BP (AA-51252), the latter within Unit IV. All of the possible egg shell fragments ranged in size from 0.8 to 1.1 cm in maximum dimension and <0.1 cm in minimum dimension. They were tentatively identified on the basis of morphology, thickness and curvature (similar to a chicken egg) (Gelvin-Reymiller 2004, personal communication).

The second group consists of 6 provenience units (37 fragments 25.4 g) located within Y5b (yellow loess between Paleosol 1 and Unit VIb sand) between 3-10 cm below Paleosol 1 and about 110 cm below stratum R4 in the 1996 bluff test pit (2.41-2.86 m below the bluff test pit datum). One of these (UA97-61-112) was located at the interface between the sand and silt Y5b/Unit VIb. All of these specimens were found within or very near the 1996 bluff test pit. These faunal fragments consisted of small mammal specimens (incisor, distal humerus, proximal tibia, all 0.2 g), large artiodactyl permanent maxillary L M1 or M2 (8.2 g), and 33 unidentified mammal bone fragments (17.0 g). These remains may be associated with Component 1, but as all Component 1 materials with the exception of one green chert flake found eroding from the bluff edge in 1999 were found above Paleosol 1; that flake was found just below Paleosol 1. Furthermore, no artifacts or features were found in association with these materials in the Bluff Test Pit.

The two remaining provenience units are from different strata. Two gastropod shells (0.1 g) were found between 30-40 cm below R4 (stratum Y4a, below Component 3), similar to living interior Alaska land snails (Family Planorbidae) (Gelvin-Reymiller 2004, personal communication). Eight small mammal specimens (0.9 g total) were found between 20-30 cm below R4 (stratum Y4a, below Component 3) within Block R.

Disturbed Faunal Assemblage

A total of 224 faunal provenience units were collected from surface or disturbed contexts at the Lower Locus between 1996-2003. These disturbed faunal remains consisted of 908 fragments for a total weight of 11,196.7 g. A number of bone fragments (including an *Equus* sp. metapodial) recovered by Holmes in 1996, but were later lost (Holmes 1999, personal communication), are not included in this analysis. Most of this fauna was found on the surface on the Lower Locus grid or eroding down the talus slope to the south of the site. A total of 138 fragments were identified to skeletal element or skeletal unit type (9166.5 g, 82% by weight). A complete or nearly complete rodent skeleton is given an NISP of 1 for the purposes of this summary.

Large cervid remains (either wapiti or moose, but most likely wapiti given the general size of the specimens) include 42 identifiable specimens. Bison remains (*Bison* sp.) include 18 identifiable specimens. Horse remains (*Equus* sp.) include a L maxillary P4 and a complete R radius. Other species represented by 1-5 NISP include caribou (*Rangifer tarandus*), *Anas* sp., saiga antelope (*Saiga tatarica*), bear (*Ursus* sp.), and various rodents specimens. Unknown mammal elements include 51 identifiable (to element) specimens. No fish remains were found in the disturbed faunal assemblage.

Table 6.23 summarizes the faunal data from disturbed contexts. Size class and taxonomic class data indicates a predominance of L-VL mammals (73% by number of fragments and 97% by weight), though mammals from various size classes are present in low frequencies. Cervids dominate identifiable taxa, with 4% of the total number of fragments and 43% of the total weight. Bison and Pleistocene horse are next with 27% and 4% of the total weight respectively. The remaining taxa are sparsely represented, with caribou, saiga antelope, bear, and various rodents with generally less than 1% of the total weight each. A single *Anas* sp. specimen was also identified. Nine percent of the faunal remains show evidence of burning, evenly split (by weight) between calcined, black, and brown-charred. Most of the specimens were unburned (59% by number of fragments and weight). Preservation ranged from very good to very poor. In terms of faunal shape, long bones dominate the assemblage (62% by weight), with flat bones, irregular bones, and teeth/enamel/mandible/maxilla fragments equally well represented (9-11% by weight).

Three of the bones from disturbed contexts were radiocarbon dated. Two of the bison bones (detailed in the Component 2 faunal assemblage above) dated to about 9500 BP. An *Equus* sp. radius was dated by Holmes in 1996 (Holmes 1998a; see also Potter 2002), returning a date of 15150±70 BP (β-109267). Three of the best-represented taxa from Gerstle River are briefly discussed in their paleontological and archaeological contexts.

Bison are found in archaeological settings in only four sites and seven components in Alaska: Broken Mammoth CZ 4 (~11500 BP), Dry Creek C2 (~10700 BP), Broken Mammoth CZ 3 (~10300 BP), Gerstle River C3 (~8900 BP), Broken Mammoth CZ 2 (~7600 BP), Delta River Overlook C3 (~3000 BP), and Broken Mammoth CZ 1a, (~2300 BP) (Holmes 1996; Bacon and Holmes 1980; Guthrie 1985; this dissertation). Stephenson et al. (2001:134-135) document radiocarbon dates associated with bison in eastern Beringia, showing a continuous presence until 170±30 BP (β-13672, Anchorage). The Gerstle River data provides support for bison hunting as a portion of Early Holocene economies.

Wapiti are found in archaeological settings in four sites and six components in Alaska: Broken Mammoth CZ 4 (~11600 BP), Mead CZ 4 (~11600 BP), Dry Creek C1 (~11100 BP) Broken Mammoth CZ 3 (~10300 BP), Gerstle River C3 (~8900 BP), and Gerstle River C5 (~8000 BP). The Gerstle River excavation data extends wapiti hunting in Alaska another 2000 radiocarbon years into the Holocene, to between 7600±140 BP and 8337±43 BP (average of two dates, see Chapter 5).

Horse and saiga antelope were found in low abundance at Gerstle River, almost undoubtedly in paleontological contexts. The terminal date for horse in Alaska is 11910±180 BP (I-12657, Fox permafrost tunnel) (Hamilton et al. 1988; see also Guthrie and Stoker 1990:242-243). The few dates on saiga antelope in Alaska cluster in two periods, the first between 40000 and 26000 BP, the second between 15000 and the terminal date of 12220±130 (AA-3077, unknown location, Alaska) (Guthrie et al. 2001:52). The correspondence of the second period and the radiocarbon date on the horse radius at Gerstle River suggests that these paleontological specimens were deposited around 15000 BP.

Table 6.23 Faunal remains from disturbed contexts summary.

Variable	*N fragments*	*% N fragments*	*Weight (g)*	*%weight*
		Size class		
Indeterminate	96	11	44.4	0
S	78	9	70.7	1
M	2	0	5.6	0
L	4	0	46.6	0
M-VL	72	8	118.3	1
L-VL	170	19	263.8	2
VL	486	54	10647.3	95
		Taxonomic Class		
Indeterminate	2	0	1.3	0
Aves	29	3	2.7	0
Mammalia	877	97	11192.7	100
		Taxa		
Cervidae (wapiti or moose)	40	4	4759.8	43
Indeterminate	796	88	2877.9	26
Bison sp.	32	4	3059.2	27
Equus sp.	2	0	435.5	4
Rangifer tarandus	2	0	28.1	0
Saiga tatarica	1	0	17.5	0
Rodentia	5	1	15.0	0
Ursus sp.	1	0	1.4	0
Anas sp.	1	0	0.1	0
		Burning type (626 frags, 4056.9 g recorded)		
Calcined	57	10	122.7	3
Black charred	96	16	135.1	3
Brown charred	3	1	116.9	3
Possibly burned	43	7	1127.6	29
Unburned	356	59	2291.9	59
Reddened	18	3	60.1	2
Indeterminate	26	4	52.0	1
Not recorded	305	NA	7256.8	NA
		Faunal shape		
Unidentified	567	62	958.1	9
Long bone	207	23	6891.5	62
Flat bone	14	2	1093.1	10
Teeth/enamel	81	9	978.9	9
Irregular/short	38	4	1261.7	11
NA (rodent skeleton)	1	NA	13.4	NA

Paleoecology of Gerstle River

The paleoecology of interior Alaska in the early Holocene (between 10000 and 7000 BP) is not well known, and only one component (Carlo Creek Component 1) has faunal remains within this period prior to the Gerstle River excavation. Both Broken Mammoth and Swan Point sites have no comparable archaeological components during this 3000 radiocarbon year (>4000 calendar year) period. All five Gerstle River Lower Locus components fall within this period, Components 1 through 5. In addition to the contribution of substantial data pertinent for the paleoecological understanding of Interior Alaska during this early Holocene period, Gerstle River contains a paleontological component, roughly dating to 15000 BP (~18000 cal BP), with multiple Late Pleistocene species, including mammoth, horse, and saiga antelope. Steppe bison, wapiti, caribou, and bear may date to this time period or could be more recent.

Figure 6.59 illustrates the animal abundance at Gerstle River and temporal variations in faunal assemblages. Fauna from disturbed contexts are combined and set at 15000 BP, though many likely date to later time periods. Horse and saiga and some of the bison and cervid remains may date to this time period. Wapiti are prominent at Gerstle River from 8800 BP to 5900 BP, and no moose-size specimens were found associated with archaeological materials. Some of the cervid remains found in disturbed contexts may be moose, but a detailed analysis is necessary to enable further identification. The absence of modern ungulates (caribou and moose) within archaeological components between 10000 and 5900 BP at Gerstle River suggests that hunting behaviors were more geared to wapiti and possibly bison during this period.

The similarities in faunal assemblages between 10000 and 5900 BP suggest that the local environment was suitable for wapiti and bison populations to thrive. The successive use of the site during this time period and the absence of later reoccupation during the Holocene (except for an occupation at the Upper Locus around 3800 BP) suggests that changes in the local environment after 5900 BP made the location unsuitable for occupation. According to Ager (1975, 1983), 8400 BP marks the beginning of the spruce-dominated boreal forest, though there is a spruce decline around 6500 BP. 6000 BP also marks the beginning of a cooling period (Hamilton et al. 1988), marked by glacial advances (TenBrink and Waythomas 1985) and alluviation along the Tanana River (Mason and Beget 1991). 6000 BP also coincides with the most dramatic hiatus in occupation in Interior Alaska (Potter 2000, 2004b). In a study of 259 dated components in Interior Alaska, there was a near absence of components between 5500-7000 BP (6200-7800 cal BP) (Potter 2004b). There was no gap in the Canadian radiocarbon record, suggesting that a depopulation of Interior Alaska may be associated with this time period. The data from occupations at Gerstle River lend further support to the hypothesis of a region-wide depopulation in the Tanana basin (whether through migration or population decline). The technology of the occupations after 6000 BP, Components 6 and 7 were fundamentally different from those who occupied the site prior to 6000 BP (Components 2-5) characterized by smaller assemblages and lack of microblade and burin technology.

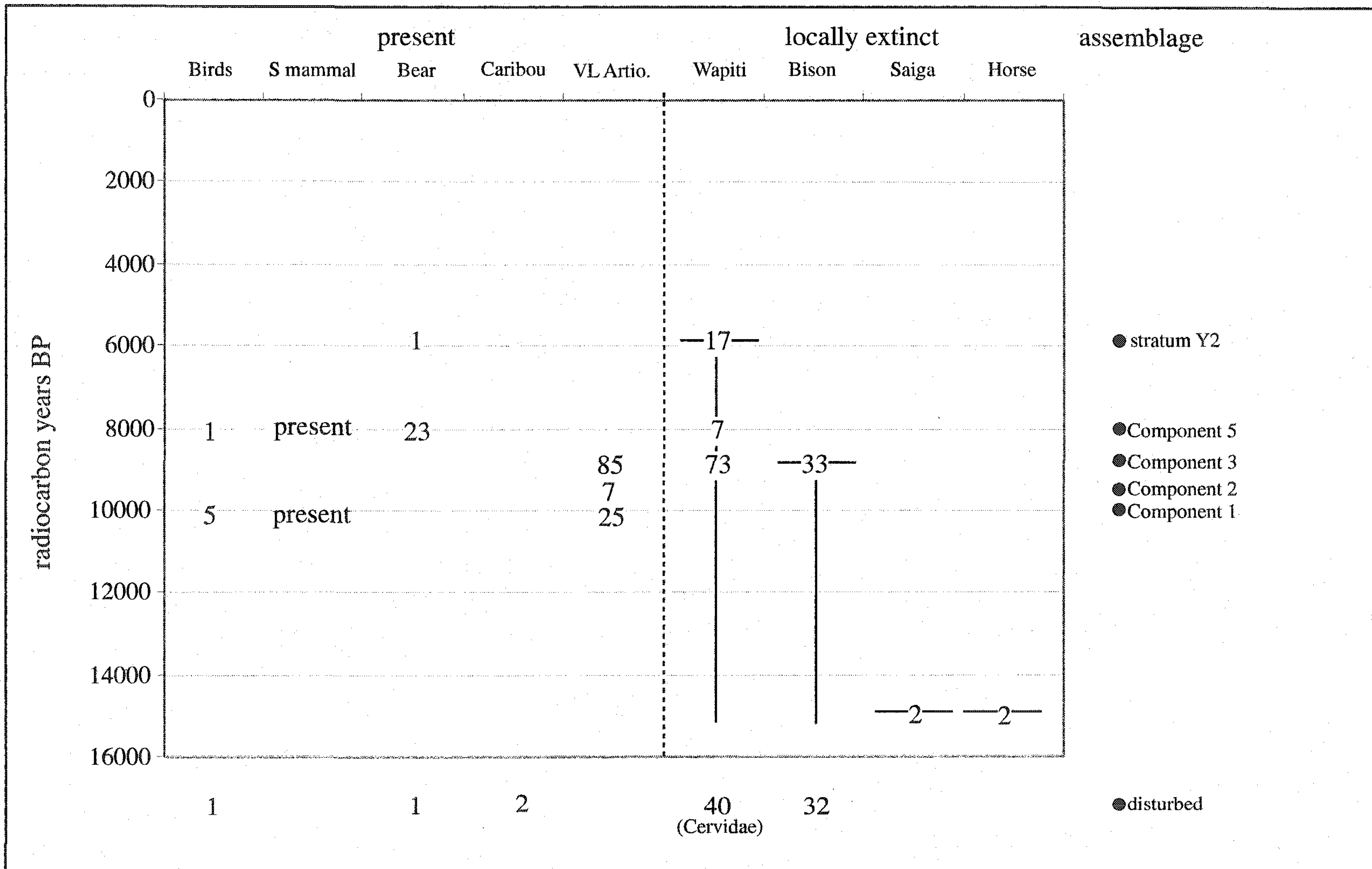


Figure 6.59 Distribution of taxa at Gerstle River by NISP. Note that the saiga has been estimated at 15000 BP, the other taxa likely date to the Late Pleistocene and Holocene periods.

CHAPTER 7. ARTIFACTS

Introduction

This chapter presents descriptive, classificatory, and analytical data on lithic and organic artifacts recovered from Gerstle River Lower Locus. Technological and economic analyses are presented in Chapter 8. Detailed analyses of spatial distributions are provided in Chapter 10. The vast majority of artifacts are flaked stone lithic material, though some cobble manuports and a mammoth ivory rod were also recovered. All of these artifacts are described in this chapter, regardless of material. The data universe for classification and description includes all lithic artifacts from the Lower Locus (n=10374). The data universe for detailed spatial, refitting and statistical analyses consists of all lithic artifacts from the Lower Locus within secure stratigraphic contexts (n=10139). This excludes a number of artifacts found on the surface or within the overburden during the excavations for the analytical purposes (n=235). Given the limited material type variability in Component 1, the spatially limited discrete loci at Component 2, and the assemblage size and variety of Component 3 artifacts, most of these tools likely relate to Component 3 (see discussion below). Note that tools from the Upper Locus were examined during the course of this study, but are not included in this analysis given the absence of a comprehensive site report that situates the artifacts within their spatial and stratigraphic contexts.

It is generally considered that archaeologists ascribe cultural meaning to various arrays of material modified by humans. Classification, description, and analysis all play important roles in this ascription. However, given the general lack of linking arguments between past human behaviors and attributes of lithic items and lithic assemblages, the approach taken in this study is primarily that of data exploration and pattern identification.

For the sake of clarity and ease of presentation and assimilation, analysis of the lithic materials is divided into three broad categories: category characterization (this chapter), technological and economic analysis (Chapter 8), and spatial analysis (Chapter 10). Category characterization includes all analysis relating to describing artifacts below the level of class and are at a primary level of inference. Technological and economic analysis relates to secondary inferences (i.e., among tool categories and variables), and spatial analysis incorporates the locational dimension. Intersite analytical comparisons incorporate other sites in the region. For example, descriptive characteristics of microblades and discrimination of modified microblade types are presented in this chapter. Issues relating to microblade production within the context of technological organization at the site are presented in the technological analysis section in Chapter 8. Microblade production among clusters, subareas, and areas of the site is examined in the spatial analysis section in Chapter 10 and comparisons of Gerstle River assemblages with other microblade assemblages in Alaska are presented in Chapter 8. Thus, analyses may be found in all three sections, with different levels of scope (e.g., component, assemblage, spatial aggregation, and the region).

The primary objective of this chapter is to describe the assemblage in sufficient detail to provide appropriate units for technological and spatial analyses in Chapters 8, 10, and 11. This chapter is organized into four sections: methods, classification, material types, and artifact descriptions for Component 1, 2, 3, 4, 5, and for disturbed artifacts. Artifact-specific research questions and methods used in the lithic analysis are presented, followed by a discussion of classification. Data on lithic raw material types are furnished. Detailed artifact descriptions are provided based on the classification system.

Methods

Lithic analyses on the Gerstle River materials were conducted in three stages: (1) data classification and basic description, (2) development of research objectives, and (3) specific statistical and formal analyses. The latter two are presented in Chapters 8, 10, and 11. The first descriptive stage focused on identification, separation, and aggregation of specimens based on basic research questions (defined below) based on raw material, technology, and classification based on previous work in the Tanana basin (Cook 1969; Holmes 2001; also Dixon 1985; Bacon 1987). The second stage consisted of the development of specific research objectives relating to site structure and organization. The third stage consisted of detailed analyses for the purpose of addressing these specific research objectives. Specific methods relating to each stage of the analysis are provided below.

The first step in analyzing the Gerstle River lithic assemblages was to identify and distinguish the variety of raw materials comprise the assemblages. Concurrently, all lithic items were separated into three basic categories: modified specimens, unmodified debitage, and microblades. These categories were considered appropriate given the large numbers of microblades (both modified and unmodified) recovered in Components 2 and 3. Modified specimens were identified on the basis of secondary usewear or retouch unrelated to manufacture or breakage. Unmodified debitage were defined as flakes, flake fragments, and angular debris showing no signs of secondary modification. I separated diagnostic core elements like microblade core tablets from this overall category. These three basic categories were then subdivided for description and analysis on the basis of the classification system described below, and are described in the following sections.

All items with diagnostic characteristics of technology or typology were examined both visually and through a Lomo MBC-10 binocular stereo microscope, normally with 8.24x and 16.32x magnification. Linear measurements were recorded using Mitutoyo digital calipers, with 0.00 mm precision, ranging from 0.00 to 150.00 mm. This level of precision is generally not duplicatable, given considerable variability within a very short distance, however measurements can reveal more detailed differences in data plots, and are rounded to appropriate levels of precision for each measure. An Acculab V-4800 electronic balance was used for all lithics except for heavy boulders, with a 0.1 g precision, and 4800 g capacity. Larger items were weighed on a Pelouze Model Y50 scale, 0.2 lb precision and 50 lb capacity.

A number of attributes were recorded for each category; these are described within category descriptions below. In addition to attributes for specific artifact categories, several other variables were added to the database, including *maximum dimension* (see Chapter 8), *modified weight*, *type*, *type2*, and *form*. Since an interval level variable measuring maximum dimension was required to compare flakes (measured by 5 mm size class intervals), microblades, and other items (all directly measured), it was necessary to construct a field labeled "maximum dimension." All items with size class information were converted to the average for the size class (e.g., SC1 [0-5 mm] = 2.5 mm, SC2 [5-10 mm] = 7.5 mm, etc.). All SC9 items (>40 mm) were directly measured. Following from the debitage analysis (presented in Chapter 8), items that weighed less than 0.1 g were estimated from average weights per size class, and labeled "modified weight."

The variable *Type* consists of tools, cores, and debitage, following Goebel's (1990:28-32) utilization of Markin's (1983) technological-morphological approach. Tools consist of all items with secondary modification such as retouch or wear; cores consist of all items with no ventral surface from which blanks (flakes or blades) were struck[1]; and debitage consists of all flaking detritus that shows no secondary modification (including diagnostic debitage such as core tablets). Note that various core parts are included under cores and core fragments in the classification system used for artifact description. The variable *Type2* is a slight modification of *Type*, consisting of tools, cores, debitage, modified microblades, and microblades (essentially separating microblades from other categories). The variable "Form" distinguishes between formal and expedient tools (see below).

Microblade Core and Core Fragment Attributes

This section describes the attributes for microblade cores and core fragments (including core tablets, facet rejuvenation flakes, but excluding microblades [see next section]). Microblade technological forms and microblade core attributes are illustrated in Figure 7.1. Microblade core attributes include maximum core height, measured from base to platform, maximum core width, measured from side to side, and maximum core length, measured from front to back. Keel elements may or may not be present. Fluting arc diameter is measured as the maximum dimension across the fluted face (or front) of the core. Flute width is measured between arrises on the fluted face. Other fluted face attributes include number of flutes, average flute width, presence of negative bulbs of force, and presence and number of hinge fractures. Core morphology includes overall form (conical, wedge shaped, or tabular), blank type (thick flake, biface, etc.), and presence of cortex. Platform attributes include platform width and length, number of flake scars and direction of flake scars (multi-directional or uni-directional), platform angle (between platform and fluted face, measured to the nearest 5° with a hand-held goniometer), and shape (oval, plano-convex, etc.). Keels may or may not be present, and attributes include shape, type of damage (bifacial retouch, crushing, etc.), and location of damage.

Microblade core tablets are produced by removal of the platform of the core, often to aid in rejuvenating the platform. Core tablets may retain fluted face elements and may extend the full length of the core (Figure 7.1, wedge core example) or may hinge out, removing only part of the core platform (Figure 7.1, conical core example). Core tablet attributes include maximum width

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[1] The three items classed as core fragments have ventral surfaces and are considered core face fragments, but are the result of core shaping rather than microblade detachment, and thus are not classed with facet rejuvenation flakes.

and length (following measurements for microblade cores), maximum thickness, number of flutes, flute widths, presence of negative bulbs of force in each flute, direction (front-struck or side-struck), degree of dorsal-platform edge crushing, core tablet termination (feather, hinge, overshoot, etc.), and platform edge angle to the nearest 5°.

Clark and Gotthardt (1999:70-73) explicitly differentiate three types of microblade core platform rejuvenation found at the Kelly Creek Site from Yukon Territory (essentially a microblade workshop): (1) *platform tablet* that often retains the fluted face of the core, though sometimes the edge crushing obscures the flutes, (2) *platform flake* (small trimming flakes), and (3) *side-blow flake* (sometimes with a characteristic gull-wing appearance). Gull-wing flakes were also identified at Campus (Mobley 1991:38-40) and Healy Lake (Cook 1969:225). Two types of core tablets are present at the site, (1) typical core tablets which resulted in complete platform removal (these were generally struck from the front (or fluted face) of the core), and (2) side-struck core tablets exhibiting a characteristic "gull-wing" appearance and that generally exhibit proximal dorsal crushing damage but generally do not retain evidence of fluting.

Microblade core facet rejuvenation flakes are produced by removal of much of the fluting face of the core and some of the basal element (or keel if it is a wedge shaped core). For this classification, any flake or microblade exhibiting an overshoot or plunging termination that retains a significant portion of the keel or bottom of the microblade core is termed a facet rejuvenation flake. These specimens often have convergence of multiple arrises at the distal end. The classification of these specimens is morphological; that is, these specimens may not have resulted from the deliberate removal of fluting face obstructions. These flakes are often the result of plunging or microblade overshoots and some may reflect intentional removal of obstacles on the fluting face (such as hinge fractures or material defects). There are numerous microblades with hinge fractures or obstructions on their dorsal aspect that the detached blade may have been intended to remove. At present, there is no systematic method for addressing these items from a typological perspective. The most useful aspect is the extent to which the keel fragment can be used to reconstruct the original core basal form. Facet rejuvenation flake attributes include length, proximal and maximum, width and thickness, number of arrises, platform type, segment, and type and location of retouch (if applicable).

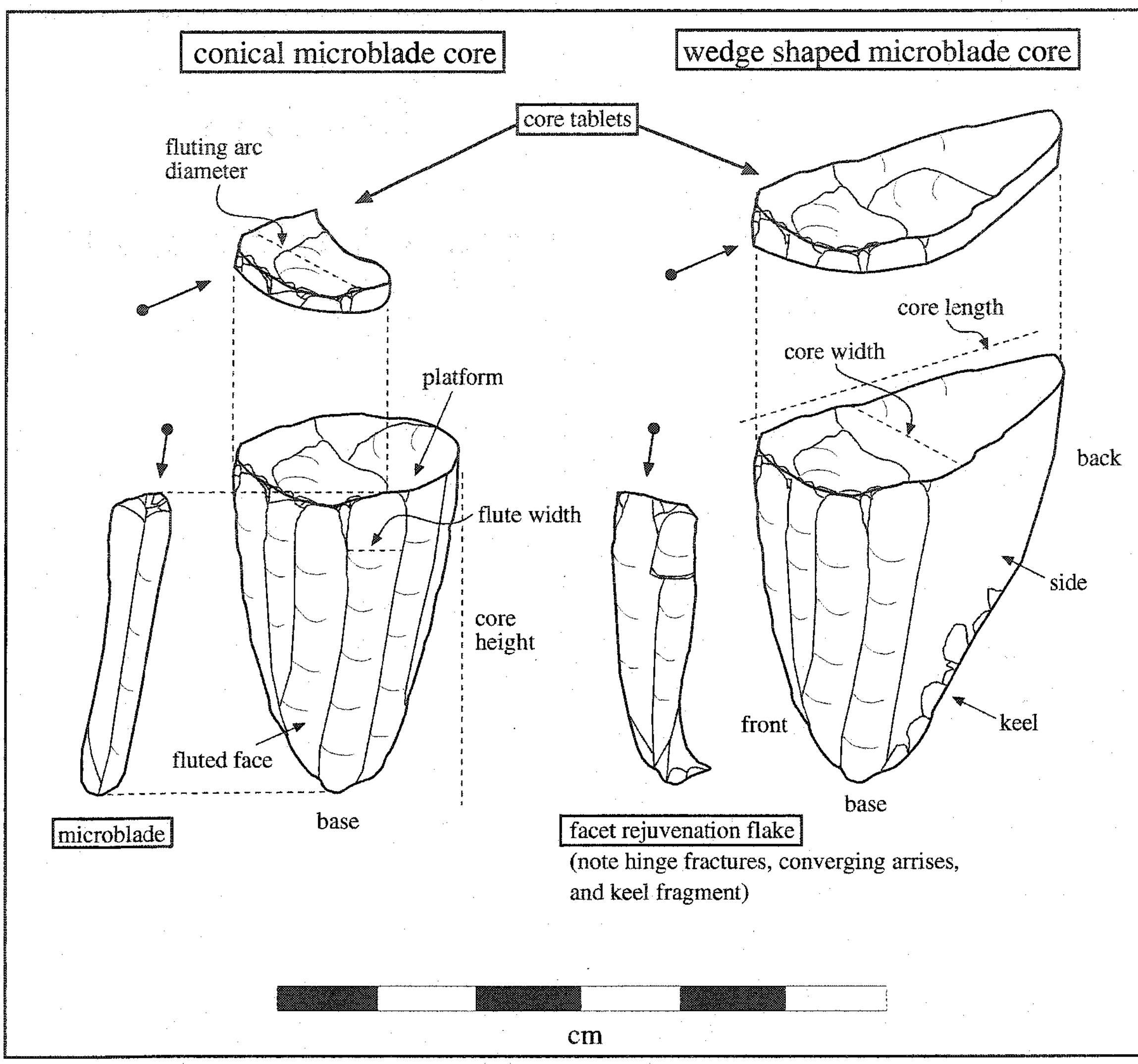

Figure 7.1 Microblade technology and microblade core attributes.

Microblade Attributes

Microblades are distinguished from other debitage by morphology and context. Microblades are elongate blades (complete non-hinged specimens generally have length:width ratios of >2) with parallel to sub-parallel lateral edges and one or more arris parallel with lateral edges. Cross-sections are generally bilaterally symmetric and geometric (i.e., triangular or trapezoidal), and they are relatively uncurved in lateral view. Platform preparation in the form of grinding and microflaking is common. Microblades are often snapped, either through production hinge or snap fractures or post-detachment breaks. Feather terminations are also common on complete specimens. In Interior Alaska, microblades sometimes exhibit retouch on lateral edges at low relative frequencies (Owen 1988:72-75; West 1981). This study shows that microblades are also commonly retouched on the distal end. Contextually, microblades co-occur with various microblade core and core-related debitage such as microblade core tablets, facet rejuvenation flakes, and core preforms. Generally, microblades are found in tight clusters suggesting production of numerous blades at one flaking episode, and removal of pieces for further modification/use (e.g., DEL-185, Potter et al. 2000a). However, microblades can often appear singly or in widely scattered contexts (e.g., XMH-839 Owl Knoll site, Higgs et al. 1999).

Separation of blades and microblades on the basis of width has generated some debate. Taylor (1962) postulated a widely used break at 12 mm, but Owen (1988:193) notes that there is considerable disagreement (see also Schoenberg 1985; Cook 1969). In the case of Gerstle River Component 3, there is no blade production industry, and very few blades were recovered, most occurring as tool blanks. Microblades (cf. prismatic flakes) showed a unimodal approximately normal distribution in length, width, and thickness, and no upper width boundary was necessary. A small number of blade-like flakes were observed in Component 3 (n=53), but were considered fortuitous, and were excluded as they had one or more non-parallel edges and/or arrises.

All items classified as microblades were measured and assessed for various attributes following Sanger et al. (1970) and Cook (1969): proximal and maximum length, width, thickness, segment (complete, proximal, medial, and distal), number of arrises, cross-section (triangular or trapezoidal), material type, platform type (simple, retouched/abraded), modification type (end modified, lateral retouch, lateral major damage, lateral minor damage, dorsal damage), weight, termination (feather, hinge, snap/break, and overshoot), and number of lateral edges modified[2]. Figure 7.2 details microblade landmarks and variables. Width is measured from the proximal end (or widest end when proximal-distal ends cannot be ascertained), following Cook (1969:87). Cook (1969:86-87) notes that width and thickness measurements should be made at the same place ~5-7 mm below the proximal end, thus reducing error resulting from the bulb of force. I have included this measurement as proximal width and thickness on complete and proximal specimens. However, I have also included maximum width and thickness measures for comparative purposes.

[2] A few microblades (n=3) could not be measured due to fragmentation during recovery or transport.

A number of derivative variables were produced for microblades, including T/W and L/W indices, and microblade fragmentation index (mbFI), derived by dividing total microblades by complete unmodified microblades.

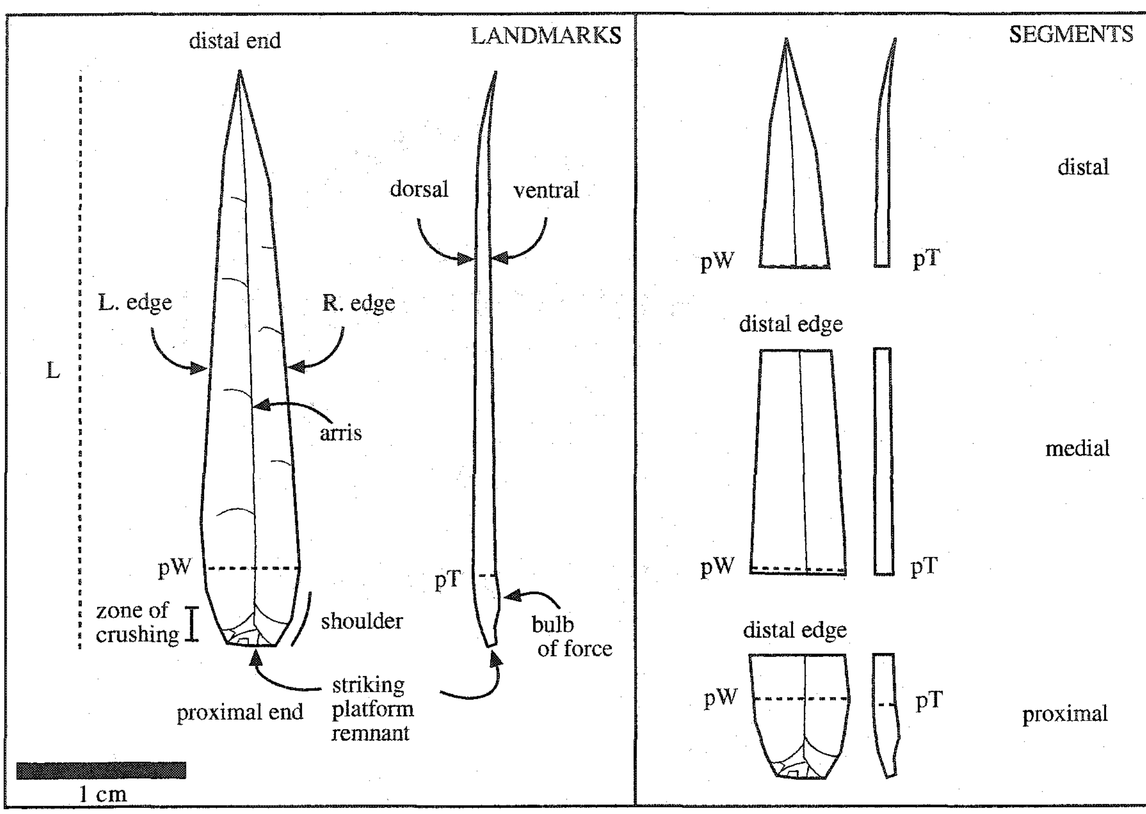

Figure 7.2 Microblade landmarks and variables.

A number of specific analyses are conducted on Component 3 and to a lesser extent, Component 2 microblades. Material types are compared to percent modified, presence of microblade core parts, and weight in order to define local and exotic material groups and potential functional groups (see discussion in Component 3 microblade section, below). Various statistics were used to explore patterns among microblade continuous and discrete variables, including one-way ANOVA, Fisher PLSD tests, χ^2 tests, unpaired t-tests, and assessments of coefficients of variation (see below). Detailed discussions of continuous and discrete variables are provided in the Component 3 microblade section, below.

Burin and Burin Spall Attributes

Burins, as described in the Alaskan literature, are defined primarily by the presence of a burin blow parallel to a blank edge that removes one or more edges (see Figure 7.3). Crushing and microflaking is often found on the burin facet, typically extending on the dorsal or ventral surface of the flake. A variety of classification schemes exist for implements commonly referred to as burins in western Beringia (Cook 1969:100-109; Mauger 1970; Morlan 1973a; Workman 1978), based on position and orientation of the burin facet, burin blank, position of usewear, and preparation of the burin platform. Unfortunately, resulting classification schemes are generally not very useful in discrimination of various morphological types and are not mutually exclusive. Cook (1969:106) recognized three burin categories at Healy Lake based on morphology: *notched*, *spalled*, and *projectile point*. Morlan (1973a:23-25) differentiated *burinated flakes*, defined by absence of usewear, and *burins*, defined by platform preparation for the burin blow and wear on the burin facet. Powers (1983:114-119) differentiated burin types on the basis of platform preparation; e.g., *burins on snaps* (where a snapped edge formed the burin platform), *dihedral burins* (where a burin facet formed the platform for subsequent burin spall removals), *angle burins* (based on presence of burin facet on lateral edges), and *transverse burins* (based on the lateral position of the burin facet and the direction of the burin spall relative to the long axis of the burin, traversing the distal end). *Core-burins* were defined by platform preparation by retouch, similar to microblade core preparation. Other technological studies in the region follow this classification (Goebel 1990; Pontti 1997). Cook's (1969) notched and spalled burins correspond with Powers (1983) transverse and dihedral burins respectively, though the former are apparently more diverse at Healy Lake. Gotthardt (1990:77-83) defined six classes of burins from the Rock River collection: *transverse burins*, *lateral burins*, *partial lateral burins*, *angle burins*, *transverse/oblique burins*, *lateral/opposing burins*, and *transverse and lateral burins*.

For the purposes of this study, burins were defined as implements where a blow was struck parallel to the edge of a blank, and burin-like wear in the form of crushing usewear or microflaking on one or more edges of the resulting facet was observed. A number of other modified flakes in Gerstle River Component 3 exhibit this type of wear at a snap or hinge fracture on a lateral edge where a roughly 90° angle was created with similar burin-like wear. Gotthardt (1990:68-102) combined burins and tools used in a similar manner in her detailed analysis of

Rock River burins, the latter comprising 34% of that sample. Modified flakes with these characteristics are discussed in modified flakes section below.

Burin attributes include (1) maximum length, width, thickness, weight, blank (flake, blade, biface), (2) type, location, and working edge angle of retouch or usewear, (3) number, location, and direction of removal of burin scars, and (4) burin scar width, damage type, location, length, and working edge angle.

Burin spalls are elongate flakes, similar to microblades, but generally thicker, with greater sinuosity, and often with evidence of retouch or wear along typically one dorsal edge (Figure 7.3) (see Giddings 1956). Cross sections are triangular or sub-rectangular. Holmes (1986:88) adds a criterion that the platform area show flake scars from the prepared burin platform. Without the parent burin, however, this last attribute is difficult to observe, and most researchers do not use this criterion (see Clark and Gotthardt 1999:98-99; Cook 1969:110-111).

Cook (1969:218) notes that one specimen exhibited dorsal retouch resembling an end scraper at Healy Lake Village Site, and Holmes (1986:88) notes four end scrapers with burin facets at Lake Minchumina. Since one of the Gerstle River Component 3 end scrapers (short-axis beveled flakes) was burinated transverse across this unifacial retouched edge, it is likely that burin spalls as a class may also be the result of refurbishing unifacial implements rather than resulting solely from burin manufacture. It is important to note that no burin spalls recovered at Gerstle River could be refitted to a burin. Variables examined include proximal and maximum length, width, thickness, weight, number of arrises, material type, platform type, termination, burin spall type (primary or secondary), length of retouch/grinding, percent of retouch/grinding length relative to total length, position of damage, type of damage, damaged edge angle, and depth of damage (if grinding and flaking, only depth of grinding was measured) (see Figure 7.3 for attribute locations).

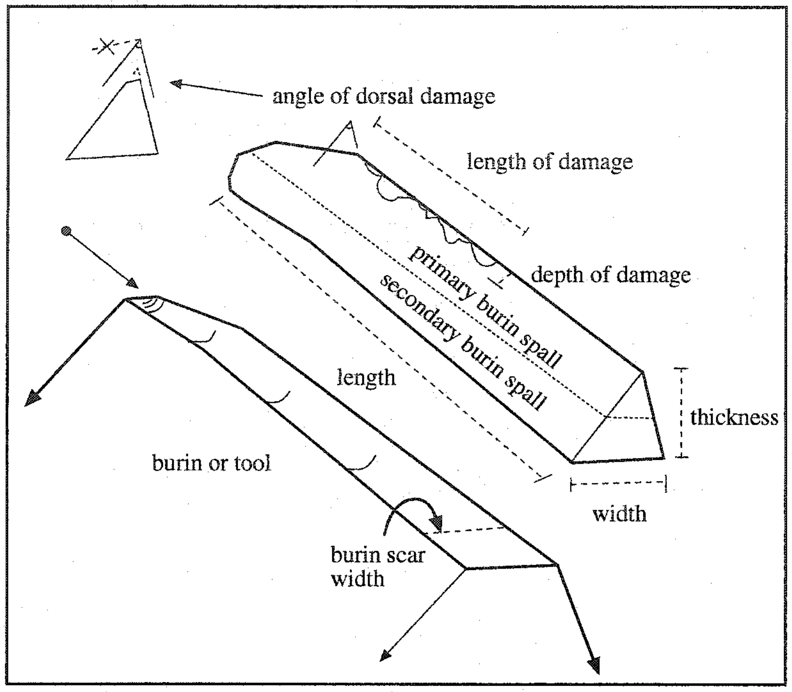

Figure 7.3 Burin and burin spall technology and attributes.

Uniface Attributes

Unifaces recovered at Gerstle River are classified as short-axis beveled flakes and long-axis beveled flakes following Morlan (1973a:20-23), Gotthardt (1990), and Mobley (1991). These terms are used to avoid the functional connnotations of end scraper and side scraper (e.g., Powers 1983:156). For comparative purposes the short-axis beveled flakes can be considered end scrapers and the long-axis beveled flakes can be considered side scrapers. Attributes examined for each specimen include length, width, thickness, weight, blank type, and retouched edge characteristics of working edge angle, diameter, length, profile (convex, concave, or straight), thickness, shape, and wear type (see Figure 7.4).

Powers (1983:73) characterized working edge angles of end scrapers in Component I as steep (70-80°) or flat (40-60°). Edge angle has been linked to resilience of material scraped, with steep angled edges used for working resilient materials (e.g., bone and antler), and flat angled edges used for hide scraping (see Wilmsen 1968:156-159). Semenov (1964:87-88) notes that a convex working edge would not penetrate skins during hide preparation. The only usewear study including Interior Alaskan scrapers (Flannigan 2002:84-85) found a high correlation between morphological type (end scrapers) and inferred function at Walker Road Component 1, including a group characterized by unidirectional scraping, and two groups characterized by unidirectional scraping and shaving (63.2% of total tested tools).

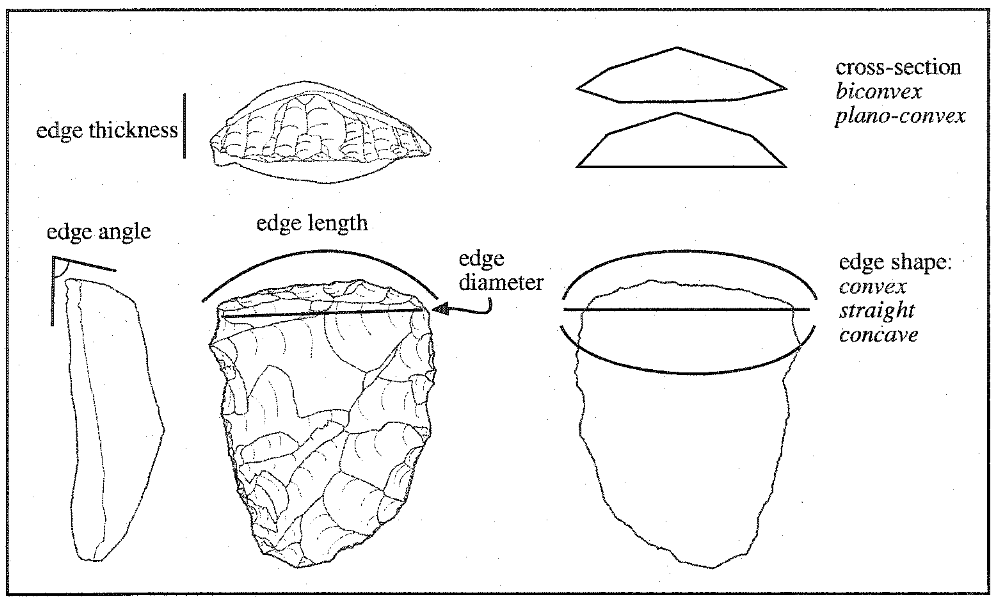

Figure 7.4 Uniface attributes.

Biface Attributes

In Interior Alaskan components dating to the Late Pleistocene-Early Holocene, there seems to be considerable variability in bifacial technology. Bifaces interpreted to be projectile points have different morphology, base shape, flaking attributes, and size, though most are lanceolate in outline. This variability is evident in bifaces from Panguingue Creek Component 2, including a very large lanceolate specimen with parallel-oblique flaking (Goebel and Bigelow 1996: Figure 7-18:a), Dry Creek Component 2 (Powers 1983; Hoffecker et al. 1996:Figure 7-10:a-k) lanceolate bifaces with pointed, convex, square, and concave bases, bimarginal and random flaking, with variable presence of edge grinding, and Healy Lake Chindadn (Levels 6-10) (Cook 1969:184-187; 192-196; plates 25-) with small triangular, square-based point and bipointed lanceolate point with no edge grinding. Bases can be pointed, convex, flat, or concave. Flaking can be collateral, bimarginal, sub-parallel, or random. Edge grinding is variable. No detailed studies of wear patterns have been conducted on Denali Tradition bifaces and functional inferences are not strongly derived, but Powers (1983:131) notes that knives and projectile points were differentiated "on the basis of wear patterns on the tip and morphological asymmetry."

In order to avoid interpretive problems derived from assignation of functional terms like projectile points and knives to the bifaces at Gerstle River, these are classed as bifaces based on morphology. These terms are often used in the literature (Powers 1983; Goebel 1990; Goebel and Bigelow 1996), but without detailed use-wear analyses, it is premature to categorically discriminate within a technology that has considerable variability in form and function.

Modified Flake Attributes

The issue of classification of modified flakes is clouded by a general lack of definition for this category, which generally is used for those items not subsumed under other definitions (like beveled flake, etc.). Modified flakes are usually not systematically dealt within at the level of assemblage, though the identification of some forms, such as gravers or spokeshaves, essentially belies the fluidity between flake tool categories. Alaskan researchers have various established separate categories for flake tools with relatively unmodified edges (Powers 1983, Cook 1969), while others have subsumed all flake tools under one classification (e.g., Mobley 1991). I use the term *modified* (following Dixon et al. 1985) rather than *retouched*, because the latter specifies a technological inference. *Modified*, in the sense of secondary modification after detachment from a core, more clearly connotes the morphological considerations and limitations to this artifact category.

In the absence of detailed high-powered microscopic examination of damage on these specimens, which is beyond the scope of the present research, this analysis is intended to identify patterns relating to the variables analyzed through macroscopic and low-powered microscopic examination for Component 3 modified flakes. To facilitate exploration of the flake tool assemblage with respect to variables such as length, type, and position of modification (relative to face and margin), modified edge shape, thickness, etc., I have approached this category as objectively as possible. The only flake tools separated from this category are beveled flakes, where the modification has substantially altered the flake margin, and burins, which are the product of a specific manufacturing technique. After analyzing various morphological and technological characteristics of modified flakes, I think that a strict demarcation on form or technology alone cannot be used to establish valid inferences on tool categories with respect to function. One specific example is burins vs. modified flakes with burin-like wear. Given the similarities in form and size, type and position of damage, and working edge angle, these implements were likely used in similar ways.

Therefore, the approach of the description and analysis of modified flakes follows from the hypothesis that modified flakes may form groups used for similar tasks, not readily apparent on the basis of single formal attributes alone (e.g., shape, position of retouch). The research questions relating to modified flakes include (1) presence of any morphological or inferred functional groupings, (2) characterization of core morphology, (3) variations related to material type, and (4) size preferences for modification. This is an exploratory macroscopic analysis, focusing on pattern recognition among a number of recorded variables to address the questions listed above. An underlying assumption to this analysis is that the overall shape of the utilized edge is important in discriminating possible grouping.

Variables used in this analysis are (1) flake type based on the presence of cortex or weathering rinds (primary, secondary, or tertiary), (2) blank type (flake or shatter, blade, or cobble), (3) segmentation (complete, proximal, medial, or distal), (4) material type (see above), (5) maximum length, (6) maximum width, (7) maximum thickness, (8) weight, (9) modification type (see below), (10) edge angle(s) (in intervals of 5°), (11) individual retouch length(s) by position, (12) sum of retouch length(s), (13) edge shape (notch, concave, straight, convex, point), (14) position of modification relative to edge (encompassing left and right lateral, proximal and distal), (15) position of modification relative to face (dorsal, ventral, and edge), (16) number of retouched margins, (17) number of flake edges, (18) percentage of retouched margins (defined as number of retouched margins/number of flake edges), and (19) modification intensity (subjectively characterized as light or heavy).

Modification type is defined by wear or retouch observable at 16.32X magnification. Categories used for this study include (1) burin-like wear (crushing/grinding of a snap or break along one edge, usually the dorsal or ventral blank face), (2) crushing (heavy non-flaking damage on the flake edge or arris), (3) polish, (4) retouch (larger flake scars suggesting intentional retouch), (5) microflaking (tiny flake scars likely produced during usewear), and (6) edge damage (chipping, nicking, or gouging on the edge of the specimen, not extending beyond 0.5 mm onto the dorsal or ventral surfaces). Burin-like wear was distinguished from crushing in that the former generally exhibited wear on only one face or edge and the latter was present on the edge itself (i.e., crushing damage extended equally on both faces). It was hoped this level of detailed analysis might indicate the presence of subgroupings within the very broad category of modified flakes that might be useful for generating inferences about site organization and site use. Analysis on spatial groupings for Components 2 and 3 is presented in Chapter 10.

Two units of analysis were used for the study of Component 3 modified flakes; the first are individual modified flakes (n=61). Given that a number of these specimens have different types and locations of damage, a second unit of analysis was used, termed modification unit (n=97). Modification units were demarcated on the basis of separate physical locations on the item (i.e., each margin or arris). Given the small numbers of modified flakes from Components 1, 2, 4, and disturbed contexts, data are summarized only, and not grouped into types.

Artifact photographs and Line Drawings

Artifact photographs and line drawings use the following conventions. All flakes and blades are oriented with the proximal end at the bottom and distal end at the top. Microblade cores, microblade core facet rejuvenation flakes, bifaces, and non-flaked lithics are oriented following general archaeological convention. Views are of the dorsal surface except where noted.

Classification

The purpose of classification, following Krieger (1944:275), is "(1) to standardize comparison of specimens over wide areas, (2) save time in sorting, tabulating, and describing masses of material, (3) to provide convenient reference forms and terms to expedite field recording, surveys, and cataloging." Classification is on the one hand, a necessary first step in any analysis of material culture, and on the other hand, a somewhat intractable problem in relating physical material to prehistoric behavior. All classification is imposed by the archaeologist (Watson, et al. 1971; Spaulding 1953, 1954; Rouse 1960). Archaeologists generally rely implicitly or explicitly on ethnographically derived data on artifact function. In the case of interior Alaska, the only ethnographic data relates to various Athabaskan groups. Unfortunately, the record reveals a technology primarily derived from organic materials (bone, antler, wood), and artifactually ephemeral features (caribou and moose fences, snares, deadfalls)

(McKennan 1959, 1981; VanStone 1974). The few categories of flaked stone types within the Athabaskan record, like tci-thos (boulder spall scrapers) and wedges, reveal the limitations of this approach. Studies on usewear, limited by their relative scarcity in the Alaskan archaeological literature, are also limited by practical concerns. The few usewear studies conducted in Interior Alaska have not furnished models to apply to the majority of recovered material. Therefore, a morphological approach seems best suited with the caveat that multiple forms may have been used for similar purposes, and similar forms may have had multiple uses. This classification and description presented here is largely exploratory in nature; however, the basic categories and groups used largely reflect common types in the subarctic literature (Morlan 1973a; Cook 1969; Powers 1983; Dixon et al. 1985; Workman 1978; Dixon 1985; Goebel 1990; West 1967; West 1981).

The classification system used here was designed to be comparable to previously described assemblages in Interior Alaska during the early Holocene (Cook 1969; Powers et al. 1983; Goebel 1990; West 1967; Mobley 1991; Powers and Hoffecker 1989; Maitland 1986; Holmes 1996; Holmes et al. 1996). Therefore, some of the terms have functional connotations. For the purposes of this study, the definitions of each class are derived from morphological considerations alone (see below). Given the limited excavation and reporting of interior Alaskan sites, wide comparability is considered the most important factor in classifying the artifact assemblage at Gerstle River.

To date, no classification system commonly used in Interior Alaska archaeology avoids conflating type, style, presumed function, and morphology. It should be noted that no comprehensive typological framework exists for many common artifact classes in the area, such as burins, various unifacially retouched flakes, projectile points, or other bifaces. A preliminary typology of notched bifaces in Alaska conducted by the author and Jody Patterson revealed a large variety of forms hitherto un-addressed in the literature (Potter 2000, 2004b).

At any level, archaeological classifications are arbitrary, and may bear no relation to real groupings as intended by the artificer. The utility of any archaeological classification scheme is the extent to which they facilitate the study of each aggregation of materials in order to identify patterning that may generate or test useful hypotheses about prehistoric technological organization.

For the purpose of this analysis, the overall category of lithics was divided into ten classes: microblade core and core parts, flake core and core parts, modified microblades, modified flakes, unifaces, bifaces, burins, burin spalls, boulder spalls, cobble tools, and debitage. Classificatory schemes above this basic class level, such as lumping microblade cores with debitage or forming a separate category for cores, are largely irrelevant for the present analysis. In some cases, subclasses were used to distinguish particular patterns noticeable within each class after the data classification analysis was completed. The classification scheme used for this analysis and data summaries are presented in Table 7.1. Definitions of each group and category are presented below.

The categories listed in Table 7.1 are unique and non-overlapping. This presents a minor problem for delineation of microblades and microblade core parts. Under this system of nested mutually exclusive categories, the total number of microblades includes (1) modified microblades, (2) unmodified microblades, and (3) microblade core facet rejuvenation flakes that meet the morphological criteria for microblades (see below). Discussion on these types is presented below.

A number of prehistoric artifact forms from Interior Alaska are not present in the Gerstle River components, including *pieces esquillee* or wedges, beaked tools, denticulates, notches and spokeshaves[3], scraper-planes, gravers, flake cores, pebble or cobble abraders, drills, copper implements, or any ground or polished stone.

Also, given the amount of preservation at the site, the relative lack of organic implements is interesting. It is possible that organic artifacts were important parts of early prehistoric toolkits, but that they are typically not preserved. The relative lack of organic artifacts at Gerstle River could be explained by a number of scenarios: (1) these items were heavily curated and/or generally discarded in specific settings elsewhere; (2) these items were present and discarded onsite but eroded to the point where they could not longer be discerned among the butchered faunal assemblage; or (3) these items were not a prominent part of the toolkit at Gerstle River Component 3. The data on bone density and %survivorship in Chapter 6 suggests that the second scenario is unlikely.

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[3] No notches or denticulates were observed, but a number of modified flakes had concave working edges, but the notches were not formed through retouch.

Table 7.1 Gerstle River lithic artifacts (Lower Locus).

Group	Category	C1	C2	C3	C4	C5	Dist.	TOTAL
TOOLS		**6**	**25**	**244**	**10**	**0**	**25**	**310**
	Modified microblades	0	13	134	0	0	8	155
	Distal modification	0	4	33	0	0	4	37
	Dorsal damage	0	0	3	0	0	1	4
	Lateral major damage	0	0	32	0	0	1	33
	Lateral minor damage	0	4	35	0	0	1	40
	Lateral retouch	0	5	31	0	0	1	37
	Burins	0	0	3	1	0	2	6
	Burin spalls	1	8	32	0	0	1	42
	Unifaces	0	1	6	0	0	4	11
	Long-axis beveled flakes	0	0	2	0	0	2	4
	Short-axis beveled flakes	0	1	4	0	0	2	7
	Bifaces	2	0	2	0	0	4	8
	Bifaces	0	0	1	0	0	2	3
	Biface fragments	1	0	1	0	0	1	3
	Projectile points	0	0	0	0	0	0	0
	Projectile point fragments	1	0	0	0	0	1	2
	Modified flakes	3	3	67	9	0	6	88
CORES		**0**	**0**	**5**	**0**	**0**	**1**	**6**
	Microblade cores and core parts	0	0	5	0	0	1	6
	Microblade cores	0	0	2	0	0	1	3
	Microblade core fragments	0	0	3	0	0	0	3
DEBITAGE		**2,034**	**803**	**6,828**	**33**	**86**	**196**	**9,976**
	Flakes, flake fragments, shatter	2,034	705	5,591	32	86	171	8,617
	Microblades	0	89	1,210	1	0	25	1,322
	Microblade core tablets	0	6	18	0	0	0	24
	Microblade core facet rejuvenation flakes	0	3	9	0	0	0	13
COBBLES		**0**	**9**	**34**	**0**	**1**	**13**	**57**
	Spall scrapers	0	1	11	0	0	8	20
	Cobble tools	0	0	3	0	0	5	8
	Hammerstones	0	0	2	0	0	5	7
	Chopper/spall core	0	0	1	0	0	0	1
	Manuport cobbles	0	8	17	0	1	0	26
TOTAL LITHICS		**2,040**	**837**	**7,132**	**43**	**87**	**235**	**10,374**

Lithic Material Types

Accurate and precise identification of lithic material types is a critical step in identifying and assessing spatial relationships of lithic debris, cores, and tools. Objectivity in delineating material types is advisable when intersite comparisons are attempted. Due to the relative lack of excavated sites in the Tanana Basin, and the general lack of consistency in material type reporting in the area, the protocols used in identifying the lithic raw materials at Gerstle River are described in detail.

First, I analyzed each lithic specimen by catalog number, thus assessing the lithics recovered in chronological order of recovery. This limited a likelihood of grouping material types by area of occurrence, etc. by focusing specifically on material characteristics in addition to providing enough lithics for each area per day to assess variability in material types. Examination of material was achieved through macroscopic and microscopic examination, with equipment described above. Through the course of this examination, material types were delineated on the basis of lithology, surface texture, light transmittance, Munsell color designation, informal color, cortex, color texture, and inclusions. Possible relationships with other material types were noted. Gray chert in particular exhibited considerable variability in color, texture, light transmittance, and inclusions. This procedure enabled an initial high-resolution approach to material type initial delineation.

The first stage of raw material classification was a high-resolution, "splitting" approach used to identify small clusters of like materials regardless of how they graded into one another at the scale of the entire site. Similarities allowed grouping at higher aggregate levels, for instance, all dark gray chert, or all banded gray chert.

The second stage involved a "lumping" approach where material types found to exhibit considerable variability, or grade into one another were lumped as one type. The purpose of this stage was to avoid over-discrimination of material types with minor differences. For most of the material types, they were distinctive enough to need little modification once they were delineated; however, the gray chert variability proved to be a problem. A number of earlier material designations were combined into a larger "gray chert" category, thus hopefully eliminating any potential misidentification. It is entirely likely, however, that a variety of different materials have been grouped. Seven distinct gray chert varieties were tentatively identified, and are discussed below under material type C1 (chert 1). Initially, over 63 different materials were classified, but were combined into the 31 basic groups presented here since positive differentiation could not be assumed without detailed chemical or mass spectrometry analysis. To cross-check the material identifications, samples of all material types were examined by UAF geologists Don Triplehorn and Mary Keskinen, geoarchaeologist Peter Bowers and archaeologist John Cook. Each material type is briefly discussed below. Areas are defined in Chapter 10: Areas A-D are in Component 3, Areas E-F are in Component 2, Areas G-H are in Component 4, Area J is in Component 5, and Area K is in Component 1.

Lithic Raw Material Descriptions

Andesite (An) at the site is moderately coarse grained (low flaking quality), opaque, with colors ranging from N4/0 (dark gray) to 10Y 5/1 (greenish gray), field characterized as gray-black. Color texture is uniform, and there are generally densely scattered black and white crystals present. A total of 226 specimens are represented at the site (2.2%), 107 from Component 1 (5.3% of total Component 1 specimens) and 119 from Component 3 (1.7%), primarily in Area C[4]. This material the most common lithic raw material at Healy Lake, with a 27.3% occurrence in all levels, most common in levels 1-5 (Cook 1969).

Argillite (Ar) at the site is homogeneous, medium grained (medium quality), opaque, generally 2.5Y 4/2 (dark grayish brown), rarely 10Y 7/1 (light greenish gray), field characterized as "dark gray." Color texture is very uniform in the argillite in Component 3, Area A, though another variety is present in Component 5, Area J. This appears banded with darker gray bands of N 3/1 (very dark greenish gray). A total of 463 specimens are represented at the site (4.6%), with 436 (6.2%) in Component 3 and 27 (31.4%) in Component 5.

Basalt (B) at the site is homogeneous, moderately coarse grained (low quality), opaque, generally N 4/1 (dark greenish gray), field characterized as "dark gray." Color texture is uniform, and widely scattered large black crystals are generally present. A total of 4 specimens are represented at the site (0.04%), all from Component 3 (0.06%). This material is found in Healy Lake at a 3.7% occurrence in all levels.

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[4] See Chapter 10, Figure 10.7 for Component 3 area and subarea locations.

There are a number of varieties of chert present at the site, these have been lumped into nine categories (C1-C9). Gray chert (C1) at the site is widely variable, with various hues and chromas, ranging from blue gray to green gray, and shades ranging from light gray to black. Even on individual items, the color can vary extensively (e.g., Figure 7.21:UA2002-62-80 and Figure 7.52:UA99-62-214). Therefore, all gray cherts are combined into C1. This material is characterized as fine grained chert, moderately translucent to moderately opaque, colors ranging from 5Y 3/1 to 5B 4/1, including N 4/0 (in Component 2, see below). The few pieces with cortex indicates stream rolled cobbles were the source. Given the rarity of cortex and small size of flakes, the original size of these cobbles cannot be calculated with confidence, but they are likely ~10 cm in diameter (certainly greater than 5 cm in diameter). Color texture is uniform, but in some cases indistinct banding and dark gray or black veins are present. A low percentage of specimens contain white, black, or orangish inclusions. A total of 3,509 specimens are represented at the site (34.8%), 60 from Component 2 (7.3%), and 3,449 from Component 3 (48.7%). This material may be correlated with gray chert, light gray chert, and dark gray chert listed for Healy Lake (Cook 1969). Cortex was present in very limited quantities (<20 specimens in Component 3), and exhibited a lighter color than the main body, generally light brown to yellowish brown, with a rough texture.

Sources for some of these cherts are likely local, in the form of stream-rolled cobbles in local rivers. Very little work has been done to source cherts more definitely in Interior Alaska, and chert from known sources have considerable macroscopic variability, such as Livengood and Landmark Gap chert. Given the spatial locations of gray chert at Gerstle River, there are likely 7 or more different varieties falling under this designation. However, more extensive work must be done to differentiate them, as they tend to grade into one another. From a sourcing perspective, all gray chert may derive from the same source, a few sources, or many sources. From the perspective of activity area delineation, several subgroupings may be derived from C1, described below.

In Areas B and C, the largest variety of gray chert is present: (C1a) medium dark gray chert (5Y 3/1) with indistinct gray banding and veins, (C1b) medium gray chert (N 4/0 with light gray spotty inclusions, (C1c) light beige chert, (C1d) blue-gray translucent chert (10B 5/1), (C1e) olive-brown gray chert (5Y 4/2), (C1f) green gray chert (5G 5/1) with widely spaced black veins, (C1g) green gray homogeneous chert (10Y 6/2), and (C1h) light blue gray chert. In Area D, a number of different gray chert varieties are present, (C1i) light gray translucent, (C1j) gray-brown opaque, and (C1k) brown-gray moderately translucent. No attempt was made to further distinguish the latter three, and they may correlate to one or more of the other varieties described in Areas B and C (C1a-C1h).

C1a is found locally clustered in Subarea B2, and is represented almost exclusively by microblades (n=206), though a few flakes (n=4) resembling this type are found in Subarea B1. C1b materials are found in Subarea B1 and B2. Two localized clusters of flakes are present (n=24), one in B1 and one in B2, NE of Feature 3. The microblades (n=19) are scattered between both clusters, and extend further south. C1c is found in Area C, tightly clustered near Feature 8, and are represented by 21 microblades, one burin spall, and 21 flakes. All gray chert in Component 2 are of this variety, which is purplish gray with fine texture, with light gray scattered inclusions. C1d and C1e are represented by 8 microblades and 15 flakes in Subarea B1. C1f are represented by 1 burin spall and 1 microblade found together in Area C. C1g are represented by 16 microblades and 47 flakes, in three concentrations in Subareas B1, B2, and B3. C1h are represented by 38 flakes clustered in Subarea B1. However, because identification cannot be certain, these are grouped together into one material type for analytical and distribution purposes.

Light gray and black banded chert (C2) is fine grained (high quality), moderately translucent, generally 10Y 5/1 (greenish gray), field characterized as light gray. Distinct black and gray bands are apparent, and there are no macroscopic inclusions. A total of 554 specimens are represented at the site (5.5%), all from Component 3 (7.8%). All materials are flakes within Subarea B1. This material may correlate with banded gray chert at Healy Lake (Cook 1969).

Grayish-brown chert (C3) is fine grained (high quality), moderately translucent, generally 7.5YR 5/3 (brown), field characterized as gray brown. Color texture is uniform, and the material is homogeneous. A total of 24 specimens (23 microblades and 1 flake) are represented at the site (0.2%), all from Component 3 (0.3%) within Areas B and C.

Black chert (C4) is fine grained (high quality), opaque (very rarely moderately translucent), with colors ranging from N 3/0 (very dark gray), N 4/0 (dark gray) to 5YR 2/1 (brownish black), and in rare cases 10Y 3/1 (very dark greenish gray), field characterized as black. Color texture is uniform, with rare mottling in the form of black blotches. The material is homogeneous. A total of 906 specimens are represented at the site (9.0%), 864 from Component 3 (12.2%) and 42 from Component 4 (97.7%). This material type may be correlated with black chert at Healy Lake, ranging from 0.8 to 5.5% at Levels 1-8, more common in upper levels.

Green chert (C5) is fine grained (high quality), moderately translucent, generally 10 GY 5/2 (grayish green) field characterized as green-gray. Color texture is uniform, and the material is homogeneous. A total of 1,769 specimens are represented at the site (17.6%), all from Component 1 (86.7%), comprising the bulk of the Component 1 assemblage. This material is clearly distinctive from other green-gray cherts at the later components.

Brown chert (C6) is very fine grained (high quality), opaque, generally 10YR 3/3 (dark brown), field characterized as brown. Color texture is uniform, and the material is homogeneous. A total of 6 specimens are represented at the site (0.05%), 5 from Component 3 (0.07%), and 1 from Component 4 (2.8%). One short-axis beveled flake in Component 3 (UA99-62-107) is slightly different, brown on distal end, but grading to predominant dark red color (see Figure 7.39).

Tan-mottled chert (C7) is fine grained, moderately opaque, generally 2.5Y 6/3 (light yellowish brown), field characterized as tan. Color texture is uniform, and there are distinctive widely scattered (5%) clear (white) crystals present. A total of 199 specimens are represented at the site (2.0%), all from Component 3 (2.8%), primarily from Subarea B4. Fifteen specimens of a similar material were found in Area C. These specimens differed in that they were coarser grained; however they were very distinct from gray or brown chert (C1 or C6). These were all microblades or utilized microblades, and represent an exotic material.

Dark red chert (C8) is medium grained, opaque, generally 2.5YR 3/1, field characterized as dark reddish gray. Color texture is uniform, and there were widely scattered small white/pink crystals present. A total of 4 specimens are represented at the site (0.04%), all from Component 3 (0.06%). Holmes (1998a) has termed this silicious material rhyolite, and Maitland (1986) has discussed a darker form of rhyolite at Chugwater. UAF geologists and Bowers consider this material to be a chert, and it is classed as such here. However, this material may be related to a form of dark red rhyolite found at other Middle Tanana sites.

Grayish-brown microcrystalline quartz (chert?) (C9) is medium-coarse grained, moderately opaque, field characterized as grayish brown. Color texture is uniform, and there are widely scattered large white crystals present. A total of 96 specimens are represented at the site (1.0%), all from Component 3 (1.4%).

Chalcedony was distinguished from chert by high translucency and waxy luster. Chalcedony varieties at the site were differentiated on the basis of color and banding. All were fine grained, with waxy luster, and mossy or greasy appearance in transmitted light. Brown chalcedony (Ch1) at the site is fine grained (high quality), moderately translucent with a greasy or mossy appearance in transmitted light, generally 2.5Y 6/4 (light yellowish brown), field characterized as beige. Color texture is generally uniform, and the material is homogeneous. A total of 369 specimens are represented at the site (3.7%), all from Component 2 (44.6%). This material may be correlated with yellow agate at Healy Lake, found in a 3.8% occurrence.

Reddish chalcedony (Ch2) at the site is fine grained (high quality), moderately translucent with a greasy or mossy appearance in transmitted light, generally 10YR 4/4 (dark yellowish brown), field characterized as reddish. Color texture is generally uniform, though it does vary from darker to lighter red, and the material is homogeneous. A total of 61 specimens are represented at the site (0.6%), 42 from Component 2 (5.1%), 17 from Component 3 (0.2%), and 2 from Component 5 (2.3%). It is possible that the material is related to Ch1 in terms of source, but the distributions are clearly spatially distinct from one another except in Component 2, Area E. It is possible that Ch1 and Ch2 are the same in Component 2, and the later analyses take this into account. Material of this type within Component 2 show heat damage (such as pot-lidding and crazing), and many are located within Hearth Feature 2. Ch2 therefore may be Ch1 with resulting color change from heat damage.

Red and black banded clear chalcedony (Ch3) at the site is homogeneous, fine grained (high quality), translucent with a greasy appearance in transmitted light, generally clear with 7.5YR 5/6 (strong brown) and black banding, characterized as reddish brown and clear. Color texture is generally clear with reddish brown and black bands or veins. A total of 138 specimens are represented at the site (1.4%), all from Component 3 (2.0%), primarily within Subarea B3, and a few in Area D.

Dacite (D) at the site is very coarse grained (very low quality), non-conchoidal, very opaque, generally 5B 4/1 (dark bluish gray) to 10GY 4/1 (dark greenish gray), field characterized as gray. Color texture varies, and there are commonly large crystals embedded in the rock. A total of 8 specimens are represented at the site (0.1%), all from Component 3 (0.1%).

Granite (G) at the site is very coarse grained (very low quality), non-conchoidal, very opaque, generally gray to brown in color. This material is the local bedrock, and is found in various levels of the site in various sizes. Discussion of this material is provided in Chapters 3 and 4.

Red Jasper (J1) at the site is moderately fine grained (medium quality), opaque, generally 10R 3/2 (dusky red) to 10YR 3/2 (very dark grayish brown), field characterized as red. Color texture includes mottling and blotches of red, and the material is homogeneous. A total of 7 specimens are represented at the site (0.1%), 2 from Component 2 (0.2%) and 5 from Component 3 (0.1%). Jasper is found in low frequencies at Healy Lake (1.7% for all levels).

Yellow Jasper (J2) at the site is moderately fine grained (medium quality), opaque, generally brown or sienna in color, field characterized as yellow-brown. Color texture includes black and darker brown spots, and the material is homogeneous. One specimen is represented at the site (0.01%), from Component 3 (0.01%).

Obsidian (O) at the site is glassy (high quality), clear to moderately translucent, generally N 1/0 (black), field characterized as gray-black. Color texture ranges from homogeneous black to black and dark gray bands. A total of 95 specimens are represented at the site (0.9%), 77 from Component 3 (1.1%) and 18 from Component 5 (20.9%). Obsidian is present at Healy Lake in Levels 1-8, with a 3.6% frequency. Five obsidian specimens were sent for neutron activation analysis, three microblades from Subarea B1 (Component 3) in 2000, one flake from Subarea C3 (Component 3), and one flake from Area J (Component 5) in 2005. All five had an AMS signature of Type A obsidian (John Cook, 2002 personal communication, Michael Glascock, 2005 personal communication). Type A obsidian is located in the Wrangell Mountains, located about 260 km (160 miles) southeast of Gerstle River. This type is widespread in central Alaska, and is associated with some of the oldest components in the region (e.g., Dry Creek Component 2, Healy Lake Village Chindadn, and Delta River Overlook [Cook 1995:94]).

Quartz (Q) at the site is crystalline (very low quality), non-conchoidal, moderately translucent, and generally clear/white in color. Large crystals are common, and color ranges from white to light gray. A total of 163 specimens are represented at the site (1.6%), all from Component 1 (8.0%). This material is found in Healy Lake at a 3.3% occurrence in all levels.

Beige quartzite (Qa1) at the site is moderately coarse (low quality), conchoidal, opaque, and generally light tan or beige in color. Color texture is uniform, and no inclusions are present. A total of 329 specimens are represented at the site (3.3%), all from Component 2 (39.7%).

Tan quartzite (Qa2) at the site is coarse (low quality), conchoidal, opaque, and generally tan in color. A total of 2 specimens are found at the site (0.02%), one in Component 1 (0.1%) and one in Component 2 (0.1%). This material is distinct from Qa1 by its coarser grain and darker color.

Quartzos-sandstone (QS) at the site is very coarse (low quality), and generally gray color. A number of spall scrapers are made from this material.

Gray rhyolite (R1) at the site is medium grained (medium quality), opaque, with colors ranging from 5Y 5/1 (gray) to 10Y 6/1 (greenish gray), field characterized as gray. Color texture is homogeneous, and there typically are mottles of widely spaced small black inclusions. A total of 430 specimens are represented at the site (4.3%), all in Component 3 (6.1%). Three clusters are present, one in Subarea B2, one in Area C, and one in Area D. This material is a common lithic material at Healy Lake at a 15.3% occurrence in all levels.

White rhyolite (R2) at the site is medium grained (medium quality), opaque, with colors ranging from 5Y 8/1 (white) to light pinkish gray, field characterized as white. Color texture is uniform, with very small brown inclusions in Component 3, Area B, and thin discontinuous black veins in Component 3, Area D. This material in Component 3, Area B exhibits dark gray coarse-grained cortex, while in Component 3, Area D, it exhibits a reddish coarser-grained cortex. A total of 704 specimens are represented at the site (7.0%), 25 from Component 2 (3.0%), 640 from Component 3 (9.0%), and 39 from Component 5 (45.4%).

Siltstone (S) at the site is moderately coarse grained (low quality), opaque, with colors ranging from 7.5YR 4/3 (brown) to 10YR 5/4 (moderate yellowish brown), field characterized as reddish-brown. The specimens are mottled with widely spaced black crystals. A total of 7 specimens are represented at the site (0.1%), all from Component 3 (0.1%).

Exotic vs. Local Raw Materials

While Gerstle River Component 3 is not a lithic production area (on the basis of flake sizes and lack of cores and early reduction flakes) and there is no known lithic raw material source nearby, an assessment of local vs. exotic lithic raw materials is necessary for defining assemblage characteristics. The distinction between local, here defined as relatively accessible lithic raw materials and exotic, defined as relatively inaccessible lithic raw materials, is based almost exclusively on Component 3 assemblage characteristics. Ancillary data, such as lack of local obsidian, are also used.

Table 7.2 lists lithic raw material summaries for Component 3. Four materials are considered local, C1, Ar, C4, and R2 on the basis of total number of lithics, total weight, core weight and tool weight, and tool number (percent modified). Figure 7.5 shows number of lithics (% of total) against weight (% of total), showing a clear separation of C1 from other material types, and a division between Ar, C4, and R2 and the remaining materials, generally represented by less than 10% of total weight and number. Figure 7.6 illustrates total weight (g) by percent retouched (for each material type), showing the separation of local materials with relatively few retouched items as a percent within each material type and exotic materials with relatively higher number of retouched items relative to total number of items for each material type. A number of materials had few retouched items or were present in low frequencies, but likely represent exotic materials as well.

Table 7.2 Component 3 lithic raw material summaries.

Mat. Type	*Total N*	*Total wt. (g)*	*N%*	*wt.%*	*Core wt.%*	*Debitage wt.%*	*Tool wt.%*	*Local/ exotic*
C1	3449	372.6	48.7	47.2	7	56	38	local
Ar	436	101.0	6.2	12.8		31	69	local
C4	864	100.0	12.2	12.7	14	43	43	local
R2	640	74.1	9.0	9.4		55	45	local
R1	430	25.5	6.1	3.2		91	9	exotic
C2	554	25.0	7.8	3.2		100	0	exotic
C7	199	19.2	2.8	2.4		83	17	exotic
C6	5	18.7	0.1	2.4		0	100	exotic
S	7	14.8	0.1	1.9		5	95	exotic
An	119	10.0	1.7	1.3		100	0	exotic
C9	96	5.3	1.4	0.7		100	0	exotic
Ch3	138	5.0	1.9	0.6		100	0	exotic
O	77	4.9	1.1	0.6		80	20	exotic
C8	4	4.1	0.1	0.5		100	0	exotic
B	4	3.5	0.1	0.4		100	0	exotic
C3	24	1.4	0.3	0.2		43	57	exotic
J2	1	1.2	0.0	0.2		0	100	exotic
D	8	1.2	0.1	0.1		100	0	exotic
J1	5	0.8	0.1	0.1		100	0	exotic
Ch2	17	0.6	0.2	0.1		100	0	exotic

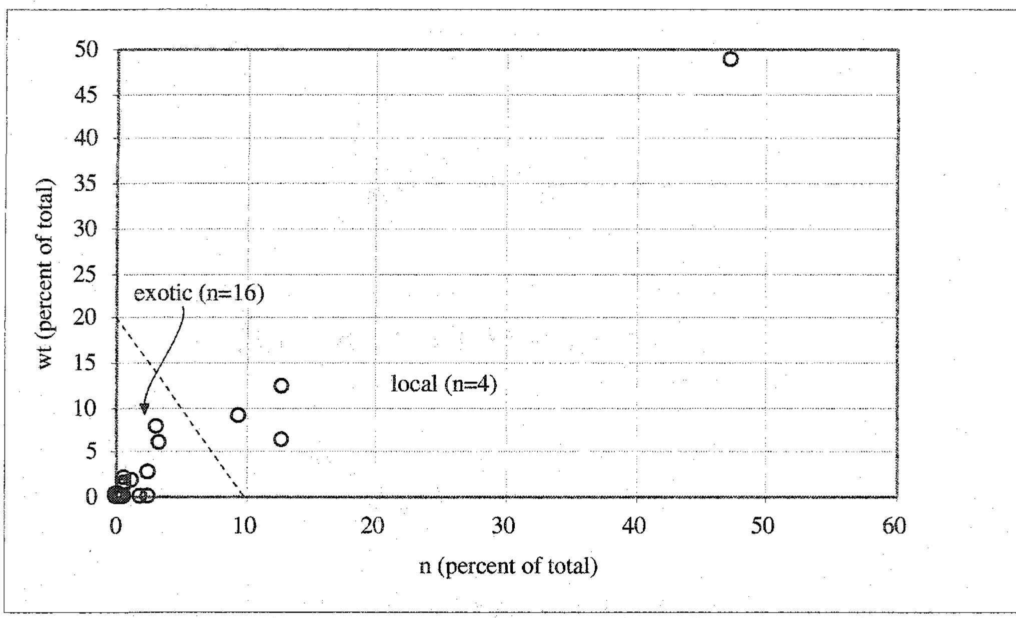

Figure 7.5 Component 3 lithic raw material type number by weight.

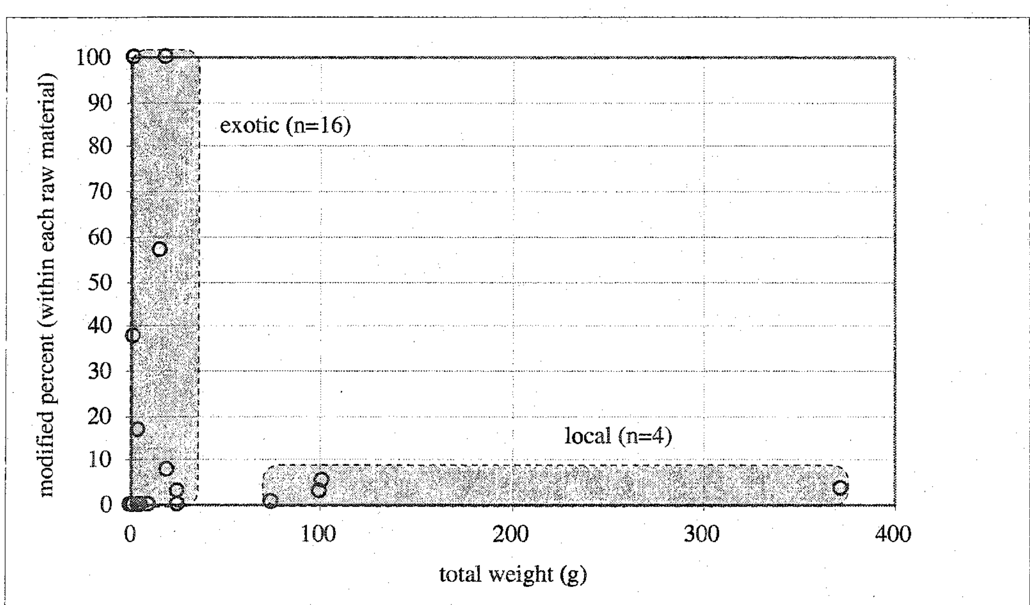

Figure 7.6 Component 3 lithic raw material type total weight by modified percent for each material.

Artifact Descriptions

Component 1 Artifacts (~10000 BP, ~11250 cal BP)

Component 1 artifacts include 2,040 individual lithic artifacts. Of these, 6 (0.3% of total items) are secondarily modified in some way: three formal tools and three expedient tools (see Figures 7.7 and 7.8). Artifacts by category include one burin spall, one biface fragment, one projectile point base, three modified flakes, one with unifacial retouch, the remaining two with edge damage, and 2,034 unmodified flaking debris. The 1999 sample of Component 1 flakes (n=12) showed one complete flake, one proximal broken flake, and ten flake fragments.

<u>Bifaces (n=2)</u>

Two bifaces were found in Component 1, located about 70 cm apart in Block R (Figure 7.7). Both are made from green chert, and are similar in thickness. They do not refit, though an intervening fragment may have been between them.

UA2001-71-810 biface

This specimen is a biface base of green chert (C5), measuring 19.0 mm long, 19.6 wide, 6.5 mm thick, and weighing 2.1 g (Figure 7.7). The outline suggests the complete biface was a lanceolate form with a pointed base. The cross-section is lenticular. The specimen is symmetrical in outline and in cross-section. The edge angles are about 50°. The flaking orientation is random. Flake scar outlines are variable, and up to 8 mm wide. The entire periphery of the fragment is edge ground, polished, and rounded, suggesting that this was the basal portion of the implement. Based on the thickness, symmetry, and point of breakage, this specimen probably was a projectile point that broke in the haft, and was subsequently removed and discarded on site. Lanceolate points with pointed bases have been found associated with microblades, unifaces, and other bifaces at the nearby site of XMH-280 in some quantity (n=14) (Bacon and Holmes 1980:plate 8).

UA2001-71-1064 biface

This specimen is a biface fragment of green chert (C5), measuring 23.2 mm long, 26.1 mm wide, 8.4 mm thick, and weighing 6.1 g (Figure 7.7). The outline suggests that the complete biface was a lanceolate form. The cross-section is lenticular. The specimen is generally symmetrical, but the removal of two flakes parallel to the long axis on one lateral edge has removed the bifacial edge. Flaking orientation is random, but generally extend across both faces. The remaining bifacial edges are edge ground and exhibit polish and rounding, suggesting that the implement was used in some fashion prior to breakage. The piece is broken on both ends, with severe damage on one lateral edge, consisting of a deep scar with a step termination and a wide scar on the reverse face removing much of the original bifacial flaking for that side. The only remaining bifacial flaking on this face is about 7.5 mm in extent. One of the breaks (oriented at the top in Figure 7.7) was apparently used as a platform for the removal of two flakes, one ending in step fractures, and the other the source of the wide scar mentioned above. Both of these flakes effectively removed the bifacial edge on that side. The purpose of these flake removals is unclear, but may have been related to forming a burin tip/edge for use as a tool. The resulting edge formed by these removals is 85°, and there is microflaking and polish on the edge of the break and at the juncture between the break scar and the two flake removals.

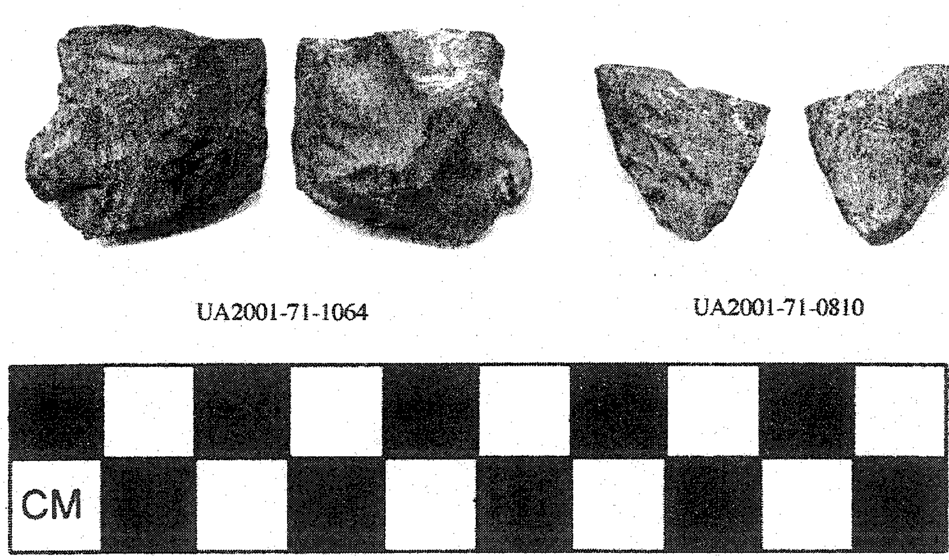

Figure 7.7 Component 1 bifaces.

Burin spall (n=1)

A single burin spall of green chert (C5) was found within Component 1 (Figure 7.8). The burin spall measured 9.4 mm in length, 6.6 mm in width, and 3.4 mm in thickness, with a simple platform and one arris. The specimen is classed as a primary burin spall, with grinding/heavy polish along the entire dorsal edge (9.4 mm long). The edge angle is 70°, similar to Component 2 and Component 3 burin spalls. Detailed description, morphological, technological, and functional analysis is provided under the Component 3 burin spall section below.

Figure 7.8 Component 1 artifacts, L-R: burin spall, modified flakes.

Modified flakes (n=3)

Three modified flakes were found in Component 1, two of green chert (C5) and one of medium grained tan quartzite (Qa2) (Figure 7.8). UA2000-54-612 measures 11.9 mm long, 14.8 mm wide, 2.6 mm thick, and weighs0.4 g. Heavy gouging is present on the left lateral edge with a working edge angle of 20° and modification length of 9.6 mm. UA2001-71-845 measures 22.8 mm long, 33.9 mm wide, 8.0 mm thick, and weighs 6.4 g. Unifacial retouch is present for 8.0 mm on the right lateral-dorsal edge (edge angle 60°) and light edge wear is present for 13.8 mm on the distal-dorsal edge (edge angle 100°). UA2001-71-1503 is an angular quartzite piece measuring 28.6 mm by 25.7 mm long by 10.6 mm and weighing 5.1 g. Heavy crushing damage is present along the left and right lateral-dorsal edges. Edge angles are 35° and 40° and modification lengths are 31.4 mm and 26.8 mm respectively.

Unmodified flakes (n=2,034)

A total of 2,034 unmodified flakes, flake fragments, and shatter (angular debris) were recovered from Component 1, weighing 141.39 g (averaging 0.07 g/flake). Detailed debitage analysis is presented in Chapter 8. Table 7.3 lists number of flakes by material type. Over 85% of the flakes were green chert (C5), with 8% quartzite and 5% andesite.

Table 7.3 Component 1 flake totals by material type.

Mat.	*N*	*%*	*Wt (g)*	*%*
C5	1764	86.73	101.06	71.48
Q	163	8.01	16.61	11.75
An	107	5.26	23.72	16.78
TOTAL	2034	100.00	141.39	100.00

Component 2 Artifacts (~9500 BP, ~10800 cal BP)

Component 2 artifacts include 837 individual lithic artifacts. Of these, 26 (3.1% of total items) are secondarily modified, with 22 formal tools and 4 expedient tools (see Figures 7.9 through 7.18). Artifacts by category include 6 microblade core tablets, 3 microblade core facet rejuvenation flakes, 13 modified microblades, 8 burin spalls, 1 uniface fragment, 3 modified flakes, 1 spall scraper, 8 manuport cobbles, 89 unmodified microblades, and 705 unmodified flaking debris. Discussion of specific category characteristics and definitions are provided in the Component 3 artifact descriptions section (see below).

Microblade core tablets (n=6)

Five microblade core tablets (one composed of two conjoined fragments), or platform rejuvenation flakes, were recovered from Component 2, all from Area E (Figures 7.9 and 7.10). All five are made from light brown chalcedony (Ch1). Three of the specimens refit as one sequence of core platform removals (UA2001-1325, UA99-62-959, and UA99-62-960). A distal fragment (UA99-62-899) conjoins to a second core platform (UA99-62-532). All Component 2 core tablets (with the exception of UA99-62-500) likely refit to the same core, as a distinctive linear inclusion is present in them.

Summary measurements include 5 core tablets; UA99-62-899 and 532 are combined. Average length is 25.65±9.13 mm, width is 13.03±5.87 mm, thickness is 4.84±1.70 mm, weight is 2.24±2.31 g, number of flutes is 1.60±2.07 (with distinct fluting present on 3 specimens), and average flute width is 5.12±0.32. Platform angle ranges between 75° and 90°, with an average of 82±8°. The bulbs of force are generally very salient, and most of the core tablets appear to have removed the entire core platform. None of the specimens exhibit modification subsequent to detachment. Morphological measurements indicate that Component 2 core tablets were generally thicker and more elongate than Component 3 core tablets, suggesting differences in core form and stage of reduction within the microblade manufacturing system.

In addition to the five microblade core platforms identified in Component 2, four other flakes have characteristics similar to core tablets (UA99-62-469, 483, 491 and 957): relatively thick proximal cross section, large platforms perpendicular to the distal surface, and light edge damage adjacent to the proximal dorsal edge. However, no clear flutes could be discerned, and their general morphology is dissimilar to the other core tablets recovered.

UA99-62-500, microblade core tablet

This specimen is a broken flake of chalcedony (Ch1) measuring 16.16 mm long, 19.09 mm wide, and 2.75 mm thick, weighing 0.4 g (Figure 7.9). Two flutes are present, with widths of 5.70 and 4.78, with a mean of 5.24±0.65 mm. Both flutes have negative bulbs, and the presence of crushing damage on the proximal edge indicates microblades were detached while the piece was part of the parent core. Platform angle is 90°. The distal termination is stepped, and likely represents a portion of the core platform.

UA99-62-532 and 899, microblade core tablet

This specimen is a complete flake (broken into two fragments) of chalcedony (Ch1) measuring 32.89 mm long (refitted), 17.85 mm wide, and 4.94 mm thick, weighing 4.1 g (Figure 7.9). Five flutes are present, in an arc with a diameter of 17.85 mm wide. Both lateral edges are perpendicular to the platform with no flake scars evident. The fluting edge is strongly convex and representative of typical wedge type core platform rejuvenation flakes. The distal termination is hinged, and length measurement should be seen as a minimum of the parent core top at this stage of rejuvenation. Flute widths are 6.27, 5.35, 4.04, 3.57, and 4.56 mm, with a mean width of 4.76±1.07 mm. All flutes have negative bulbs present. Crushing and polish is evident on the platform edge and down the right lateral edge of the tablet. Platform angle is 80°.

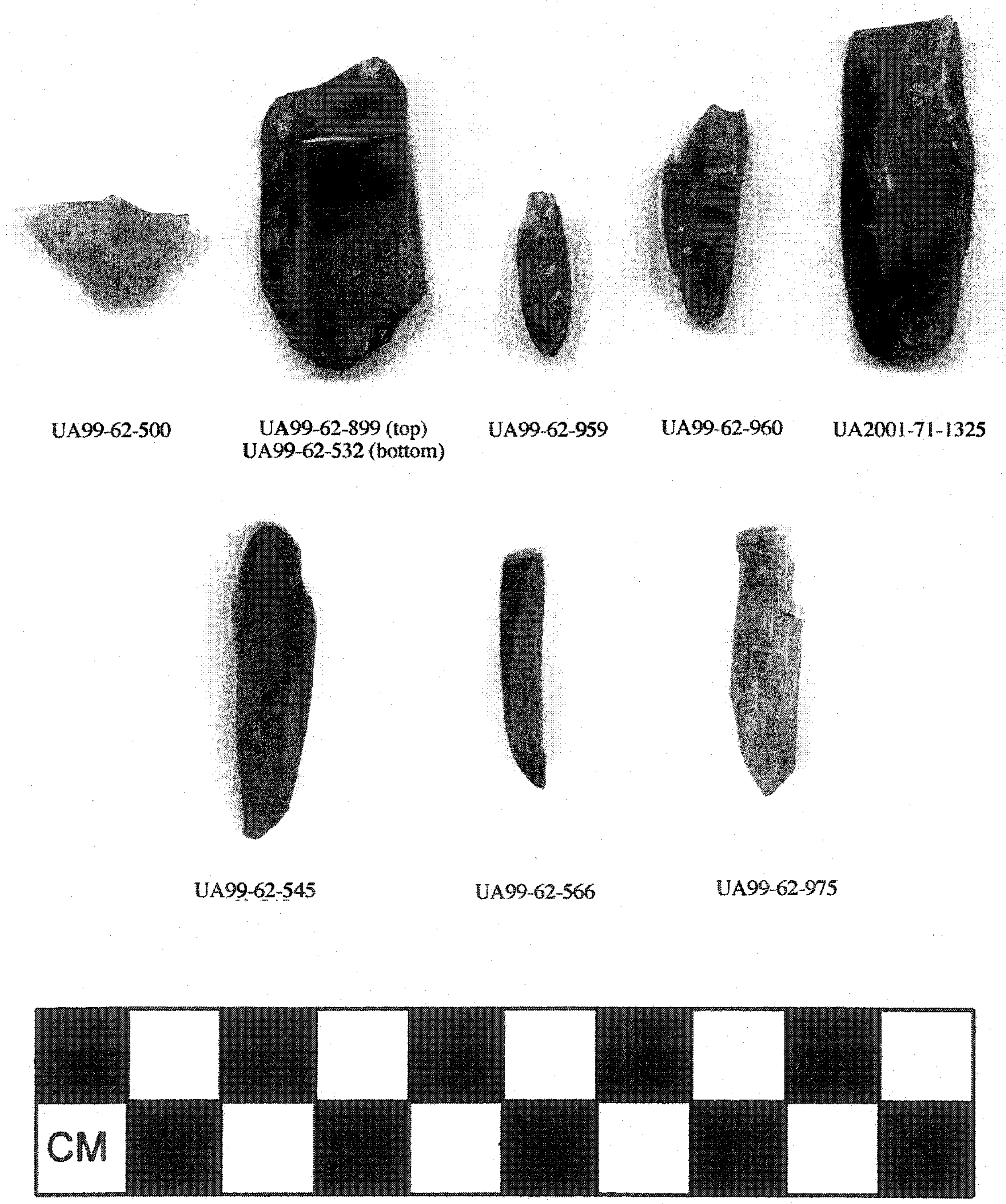

Figure 7.9 Component 2 microblade technology (top row, core tablets, bottom row, facet rejuvenation flakes).

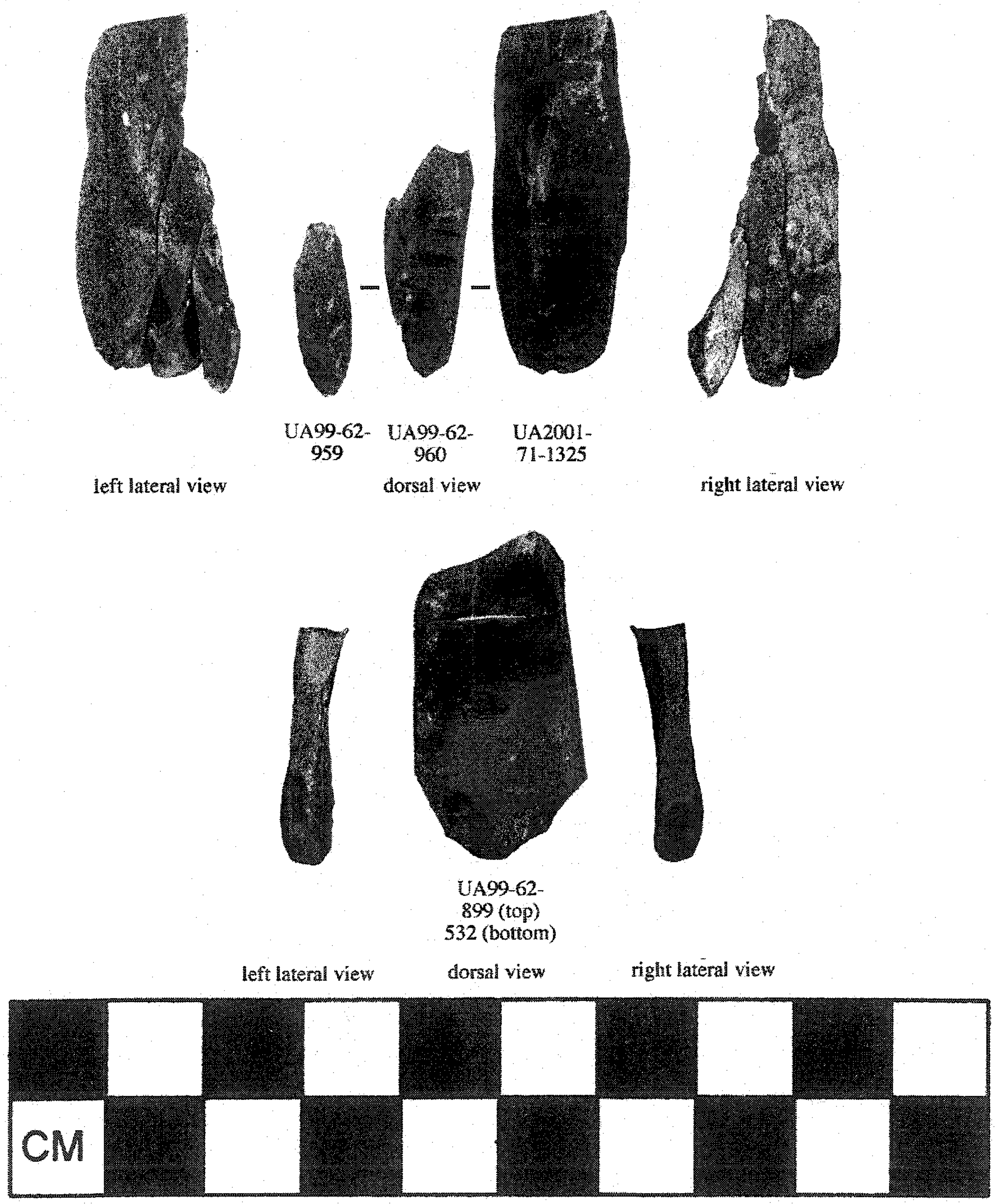

Figure 7.10 Component 2 microblade core tablet conjoins and refits.

UA99-62-959, microblade core tablet

This specimen is a complete flake of chalcedony (Ch1) measuring 18.05 mm long, 5.76 mm wide, and 4.21 mm thick, weighing 0.3 g (Figure 7.9). No flutes are evident, but retouch is present along the left lateral margin. This likely represents among the first large removals to prepare the core platform. Flake termination is feathered. Further discussion is provided under refitted core tablets UA99-62-960 and UA2001-71-1325, below.

UA99-62-960, microblade core tablet

This specimen is a complete flake of chalcedony (Ch1) measuring 24.07 mm long, 8.19 mm wide, and 4.87 mm thick, weighing 1.1 g (Figure 7.9). No flutes are evident, but retouch is present along the left-distal lateral margin. This flake is among a series of three core tablets to a microblade core (see discussion under UA2001-71-1325).

UA2001-71-1325, microblade core tablet

This specimen is a complete flake of chalcedony (Ch1) measuring 37.09 mm long, 14.28 mm wide, and 7.44 mm thick, weighing 5.3 g (Figure 7.9). One flute is clearly evident, with a width of 5.37 mm. Flake morphology suggests detachment from a wedge shaped microblade core. The distal end shows the same hinging as the other large core tablet from Component 2, UA99-62-532, and a linear inclusion is present in both suggesting that this core tablet was detached prior to the latter. Edge damage is limited to the fluted end and the extreme left-distal lateral margin. Given lack of retouch between the earlier core tablet detachments (UA99-62-959 and 960), it is likely that all three were removed in close succession, though at least one microblade was removed from this core tablet while attached to the parent core. Platform angle is 75°.

Microblade core facet rejuvenation flakes (n=3)

Three specimens typed as microblade core facet rejuvenation flakes were recovered from Component 2, in Area E (Figure 7.9). This type is based on the presence of a keel element and are often the result of plunging or microblade overshoots. Typically facet rejuvenation flakes may be used to remove obstacles to clean microblade detachment, such as numerous hinge fractures, or material defects. These specimens may or may not have been intended to rejuvenate the fluted face, but their presence attests to core morphology. Both specimens in Component 2 have keels distinctive of wedge shaped microblade cores.

UA99-62-545, microblade core facet rejuvenation flake

This specimen is a complete gray chert microblade (C1) measuring 33.63 mm long, 9.40 mm wide, and 2.52 thick (at distal end), weighing 0.6 g (Figure 7.9). Four parallel arrises are evident on the dorsal surface. The distal portion is strongly curved, and only a small portion of the keel element is present.

UA99-62-866, microblade core facet rejuvenation flake

This specimen is the distal portion of a gray chert microblade (Ch1) measuring 25.48 mm long, 5.76 mm wide, and 2.29 mm thick (at distal end), weighing 0.3 g (Figure 7.9). Five parallel arrises converge at the distal end, which is strongly curved.

UA99-62-975, microblade core facet rejuvenation flake

This specimen is the distal portion of a chalcedony microblade (Ch1) measuring 28.36 mm long, 6.74 mm width, and 2.74 thickness (at distal end), weighing 0.4 g (Figure 7.9). Four parallel arrises are evident on the dorsal surface. The keel element exhibits polish and light crushing.

In addition, a number of microblades and microblade fragments exhibit numerous hinge fractures below the platform, which may indicate their removal as part of a facet rejuvenation strategy aimed at the production of parallel-sided microblades.

Microblades (n=105)

Morphological and technological descriptions and discussion of microblades is presented below in the Component 3 microblade section. Microblade orientation, attributes, and measurement locations are provided in Figure 7.2.

There are 105 microblade and microblade fragments in Gerstle River Component 2, three classified as microblade core facet rejuvenation flakes, 13 classified as modified microblades, and 89 classified as unmodified microblades. A representative sample of Component 2 microblades is presented in Figure 7.11, derived from Component 3 percentages of complete, proximal, medial, and distal segments, and relative frequencies by material type (compare with Figure 7.23 for Component 3). Microblades make up 13% of all flaked stone lithics by count and 18% by weight. Total unmodified microblades weigh 9.92 g (17% of total Component 2 assemblage weight), and total modified microblades weigh 0.87 g (1%). Modified microblades are illustrated in Figure 7.12.

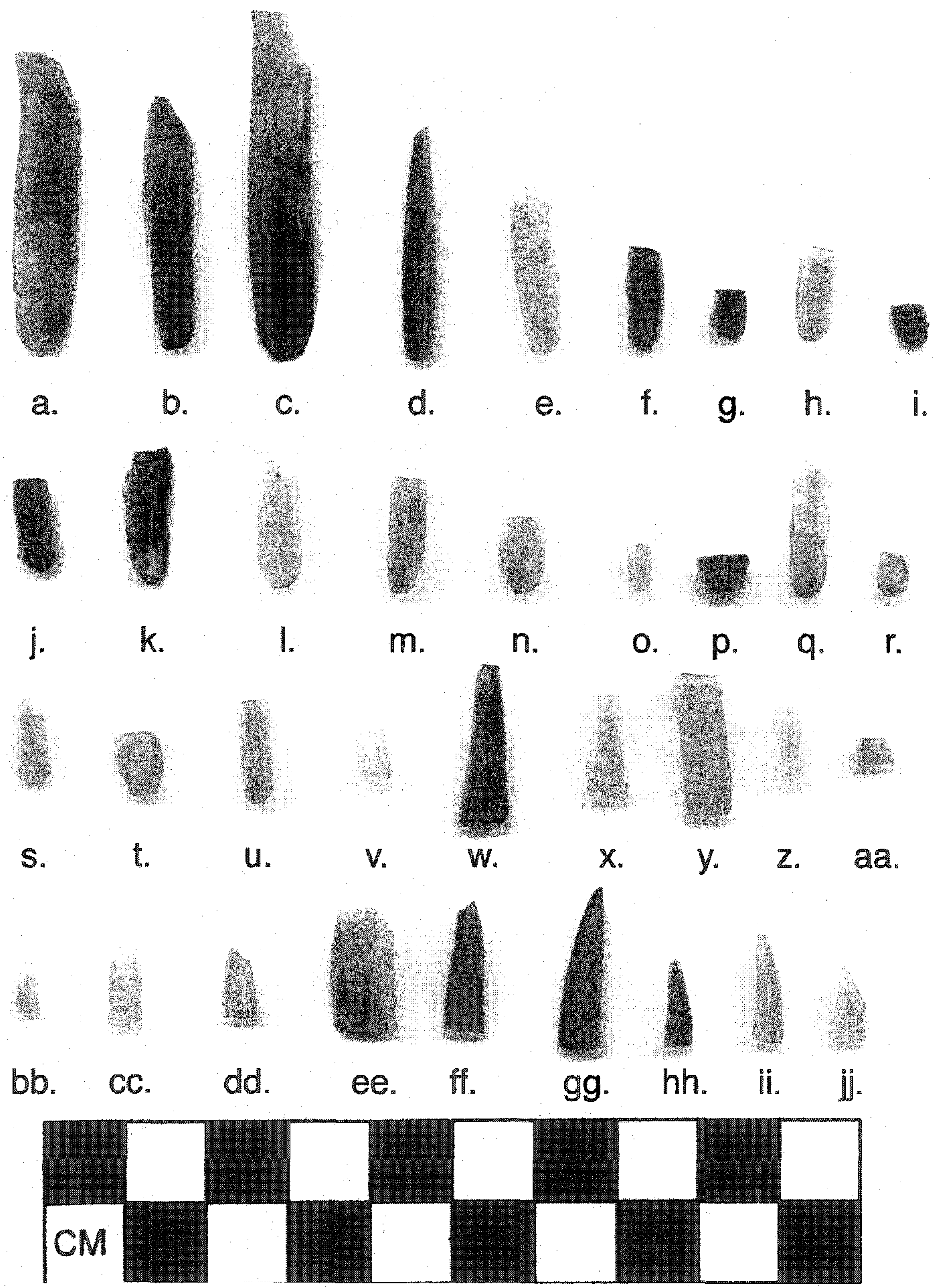

Figure 7.11 Component 2 microblades (representative sample for segment and material type).

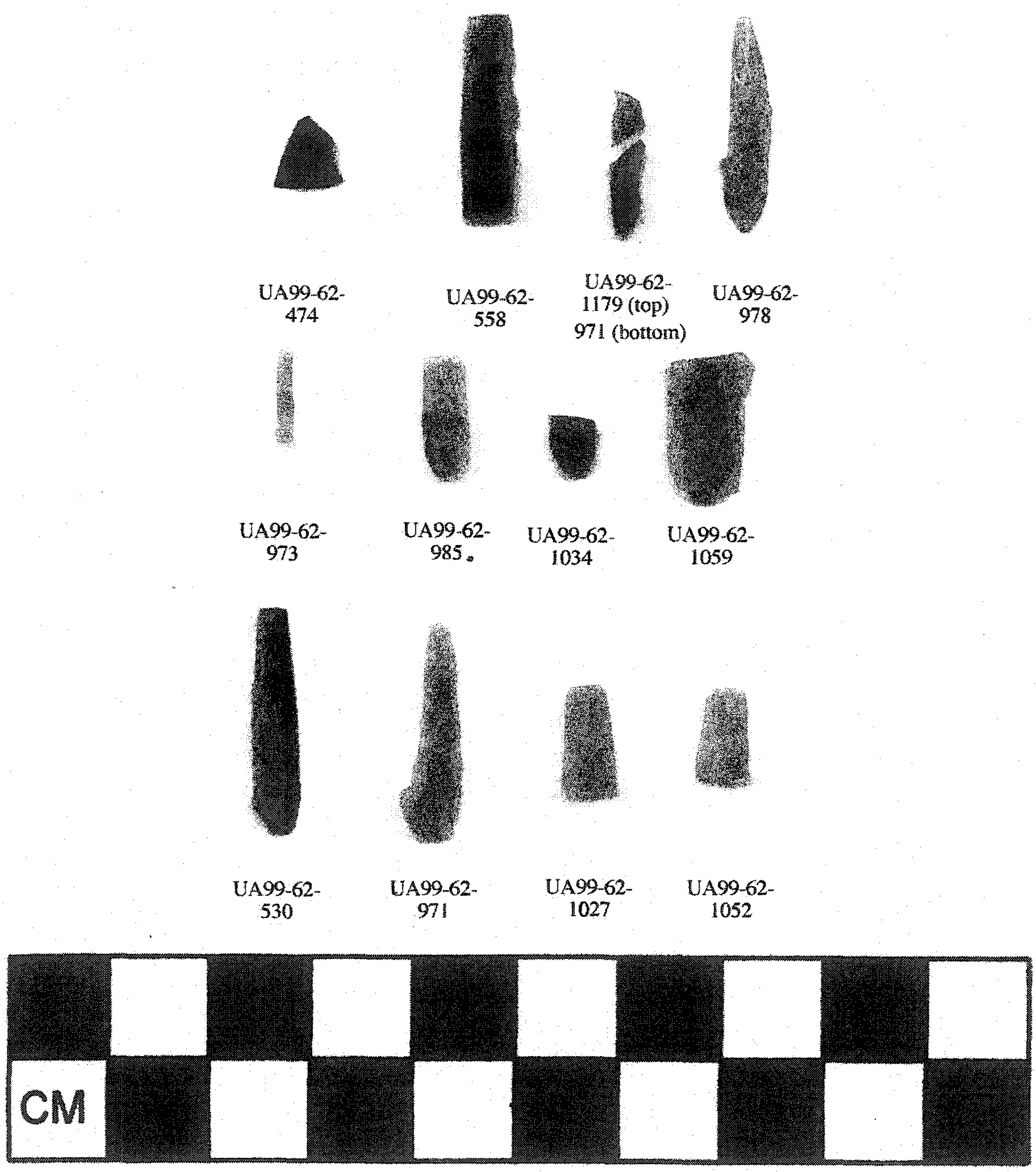

Figure 7.12 Component 2 modified microblades.

Microblade Groups

Following the protocols described in the Component 3 microblade section, Component 2 microblades have two of the three groups, Group B consists of C1 and Ch1 with 8-9% modified, and constitutes the bulk of the microblade assemblage (n=101, 96%). Group C consists of Ch2 and J1 with 100% modified, and are rare (n=4, 4%). Core fragments are present for Ch1. On this basis, Group B likely represents microblades manufactured and modified on-site and Group C likely represents exotic materials manufactured off-site and discarded on-site, similar to Component 3 groups (see below). There are no significant differences in continuous variables by microblade group, though this likely relates to the small size of the sample for Group C (see below).

Summary metric statistics on microblades in Component 2 are provided in Table 7.4, including length, proximal width, proximal thickness, thickness/width (T/W) index, and modified weight by segment, category, modification type, material type, and microblade group. A series of one-way ANOVA tests, unpaired t-tests, and Fisher PLSD tests were conducted to identify any significant differences in the metric variables in microblades among these groups (see below for discussion of ANOVA and Fisher PLSD tests).

Length

Sixteen complete microblades were recovered in Component 2 (15% of total), with an average length of 28.6 mm. ANOVAs showed significant differences in length for segment ($F=37.79$, $df=104$, $p=0.000$) with complete microblades longer than other segments, and both proximal and medial segments longer than distal segments.

Material types do have differences in microblade length values ($F=3.99$, $df=104$, $p=0.010$), where C1 microblades are on average 6.0 mm longer than Ch1 microblades, though this relates to the greater frequencies of complete microblades in C1 (27.8% vs. 9.2% respectively). Mean lengths of complete specimens did not differ between C1 and Ch1 microblades (30.2±1.8 mm vs. 26.0±12.6 mm respectively; $t=1.07$, $df=14$, $p=0.303$), though Ch1 had a much greater variability. Lengths differences were reflected in cross-section, with triangular cross sections (1 arris) 3.7 mm shorter than trapezoidal cross-sections (2+ arrises) ($F=4.46$, $df=104$, $p=0.037$).

Table 7.4 Summary metric statistics on Component 2 microblades.

Variable	*N*	*L*	*pW*	*pT*	*T/W index*	*Mod weight*
Segment						
Complete	16	28.6±7.7 (3)	5.7±1.7 (3)	1.5±0.6 (2)	25.9±8.4	0.33±0.27 (3)
Proximal	45	10.6±5.9 (2)	4.8±0.8 (1)	1.1±0.3 (2)	23.7±6.3	0.05±0.10 (1)
Medial	23	9.3±4.9 (2)	4.5±1.5 (1)	0.8±0.3 (2)	20.3±8.7	0.06±0.06 (1)
Distal	21	14.2±7.1 (3)	4.9±1.7	1.2±0.6	24.2±7.0	0.10±0.11 (1)
Complete+Proximal	61	15.3±10.2	5.0±1.2	1.2±0.4	24.3±6.9	0.12±0.19
Cross-section						
Triangular	49	11.9±6.6 (1)	4.7±1.5	1.1±0.4	23.0±7.5	0.06±0.20 (1)
Trapezoidal	56	15.5±10.4 (1)	5.0±1.2	1.2±0.5	24.1±7.6	0.14±0.07 (1)
Modification						
Unmodified	92	13.9±9.3	4.9±1.3	1.2±0.5	23.5±7.3	0.11±0.17
Modified	13	12.8±6.2	4.9±1.6	1.1±0.3	24.0±9.3	0.07±0.06
Modification Type						
End modification	4	10.2±3.7	4.6±2.6	0.9±0.3	26.5±16.3	0.07±0.09
Lateral minor damage	4	15.8±7.0	5.4±0.5	1.0±0.2	19.4±4.3	0.05±0.04
Lateral retouch	5	12.5±7.4	4.7±1.4	1.2±0.3	26.2±3.7	0.08±0.07
Modification Type (combination)						
Lateral (all)	9	14.0±6.9	5.0±1.1	1.1±0.3	23.2±5.1	0.06±0.06
Material Type						
C1	36	17.8±9.9 (1)	5.0±1.5	1.2±0.4	24.7±6.3	0.13±0.14
Ch1	65	11.8±7.9(1)	4.9±1.3	1.1±0.5	22.9±8.2	0.09±0.17
Ch2	3	11.6±7.5	3.9±1.0	1.1±0.4	27.4±3.5	0.09±0.10
J1	1	7.0	6.6	1.4	21.2	0.03
Microblade Group						
B	101	13.9±9.1	4.9±1.4	1.1±0.5	24±8	0.10±0.16
C	4	10.5±6.6	4.6±1.6	1.2±0.4	26±4	0.07±0.09
TOTAL	105	13.8±9.0	4.9±1.4	1.1±0.5	23.6±7.5	0.10±0.16

(#) = number of significant pairwise differences at $p<0.05$ using ANOVA and Fisher PLSD for groups with $n>2$ and unpaired t-test for groups with $n=2$.

While Component 3 microblades showed length differences between modified and unmodified specimens, Component 2 showed no significant differences ($F=0.17$, $df=104$, $p=0.677$). Length by modification type also showed no significant differences ($F=0.77$, $df=12$, $p=0.491$). Histograms for modified and unmodified microblade lengths are illustrated in Figure 7.13. The overall distribution is similar to that of Component 3, but the microblades are longer in Component 2, and the distribution is more right skewed. Two groupings can be identified, complete microblades between 23 and 45 mm and broken microblade fragments between 3 and 20 mm. Modified microblades are more limited in length dimension, and a cut-off around 23 mm is evident. These data reinforce those from Component 3 that microblade length may not have played the most important role in selection for use.

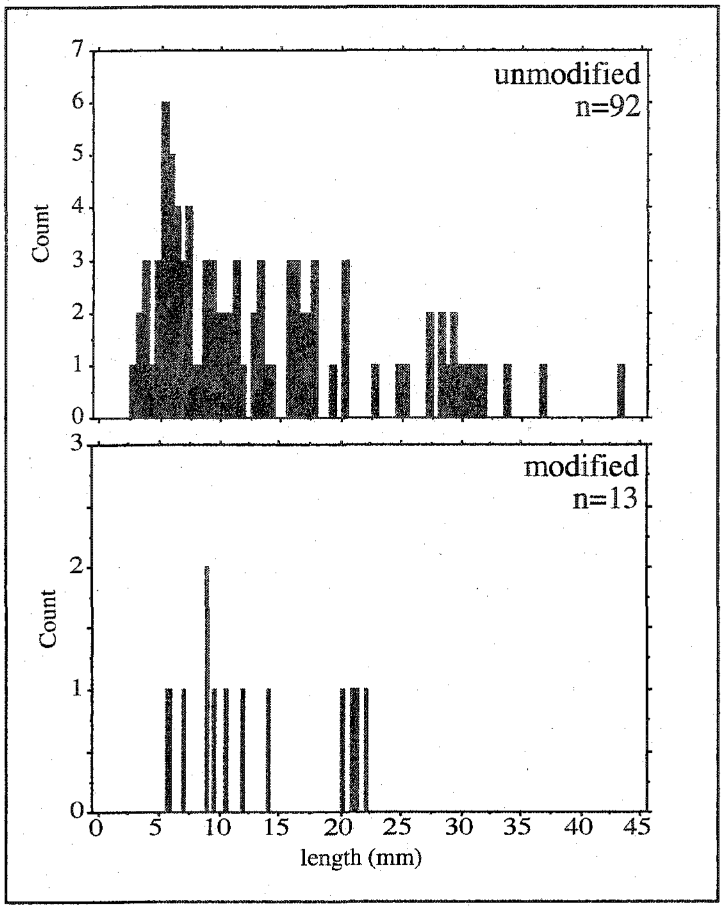

Figure 7.13 Component 2 microblade length histograms.

Width and Thickness

Analysis of width and thickness follows that for Component 3 microblades (see below). Modified and unmodified microblades have no significant differences in width, thickness, or thickness/width (T/W) index[5]. Modification type, material type, microblade group, and cross section also showed no significant differences in these variables[6].

Figure 7.14 illustrates microblade width for all specimens, material type (where n>15), and modification presence. Material type C1 and Ch1 have similar overall distributions, but Ch1 shows a very clear bimodality with peaks at 4.0-4.5 mm and 5.0-5.5 mm, but a marked decrease between 4.5 and 5.0 mm. This strongly suggests a width preference between 4.5 and 5.0 mm for microblades selected for modification and removal from the site. Modified microblade (discarded on-site) width peaks between 4.5-5.5 mm, supporting this hypothesis. Material C1 does not have a bimodal distribution, though the 5.0 to 5.5 mm bar appears to be depressed relative to the 4.5-5.0 mm bar (see Figure 7.14). These patterns suggest that within Group B, microblade selection for use was based on widths between 4.5 and 5.0 mm for Ch1 and between 5.0 and 5.5 mm for C1.

Modified microblade widths distribution appears to be peaked when compared with unmodified microblades. This suggests a narrower tolerance for width in microblade selection than exhibited in Component 3, perhaps reflecting a narrower range of uses.

[5] t-test results (df=103): proximal width by modification presence, t=0.09, p=0.925; proximal thickness by modification presence, t=0.59, p=0.556; T/W index, t=-0.23, p=0.816.
[6] ANOVA results for modification type(df=12): proximal width, F=0.26, p=0.776; proximal thickness, F=1.19, p=0.345; T/W, F=0.75, p=0.499. ANOVA results for material type (df=104): proximal width, F=1.08, p=0.360; proximal thickness, F=0.69, p=0.557; T/W index, F=0.81, p=0.489. ANOVA results for microblade group (df=104: proximal width, F=0.19, p=0.667; proximal thickness, F=0.02, p=0.879; T/W index, F=0.33, p=0.567. ANOVA results for cross-section (df=104): proximal width, F=1.19, p=0.277; proximal thickness, F=3.61, p=0.06; T/W index, F=0.66, p=0.419.

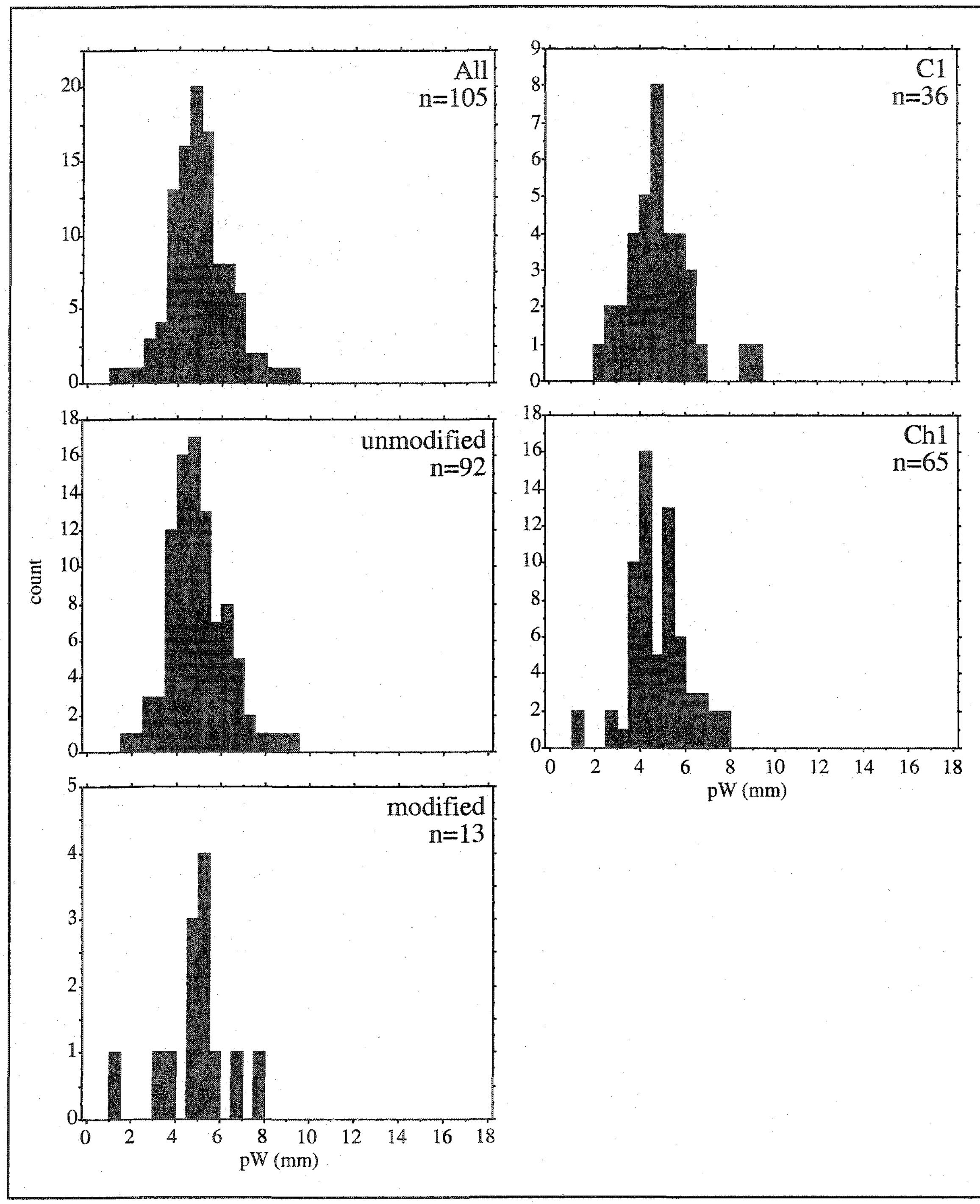

Figure 7.14 Component 2 microblade width by modification and material type.

Segment Representation

Segment representation and inferred segment deletion are discussed below in the Component 3 microblade section. Microblade segment types for Component 2 include 16 (15.4%) complete, 45 (43.3%) proximal segments, 23 (22.1%) medial segments, and 21 (20.2%) distal segments (Table 7.5). Based on the material excavated, at least 56 microblades were detached from cores in Component 2 ($\sum$ complete and proximal unmodified segments). Microblade fragmentation index (see below) is 7.4, relatively low when compared with Component 3 (mbFI = 36.5), reflecting the fact that fewer microblades were broken in Component 2. All other things being equal (i.e., assuming no microblades were removed from the site), medial fragments should be represented by at least as many as proximal fragments, yet there are only 51% as many medial fragments, and most of them are modified. These data indicates that medial microblade segment frequencies are severely depressed in Component 2, suggesting that many medial segments were removed from the site, perhaps as insets in composite tools.

Table 7.5 Component 2 microblade frequencies of segment by modification.

Segment	*MB*		*MMB*		*Total*	
	N	%	*N*	%	*N*	%
Complete	15	16.3	1	7.7	16	15.4
Proximal	41	44.6	4	30.8	45	43.3
Medial	16	17.4	7	53.8	23	22.1
Distal	20	21.7	1	7.7	21	20.2
TOTAL	92	100.0	13	100.0	105	100.0

The majority of microblades are made from C1 and Ch1, and segment percentages were compared with Component 3 microblade Group B (inferred to represent on-site manufacture and use of microblades) and Group C (inferred to represent exotic materials manufactured off-site and discarded on-site, see below) (Figure 7.15). Component 2 microblades were generally similar to Component 3 Group B, but the medial values are depressed even further than for this group, suggesting that Component 2 microblade production was more efficient at producing microblades suitable for use (and thus, removal from the site) than Component 3.

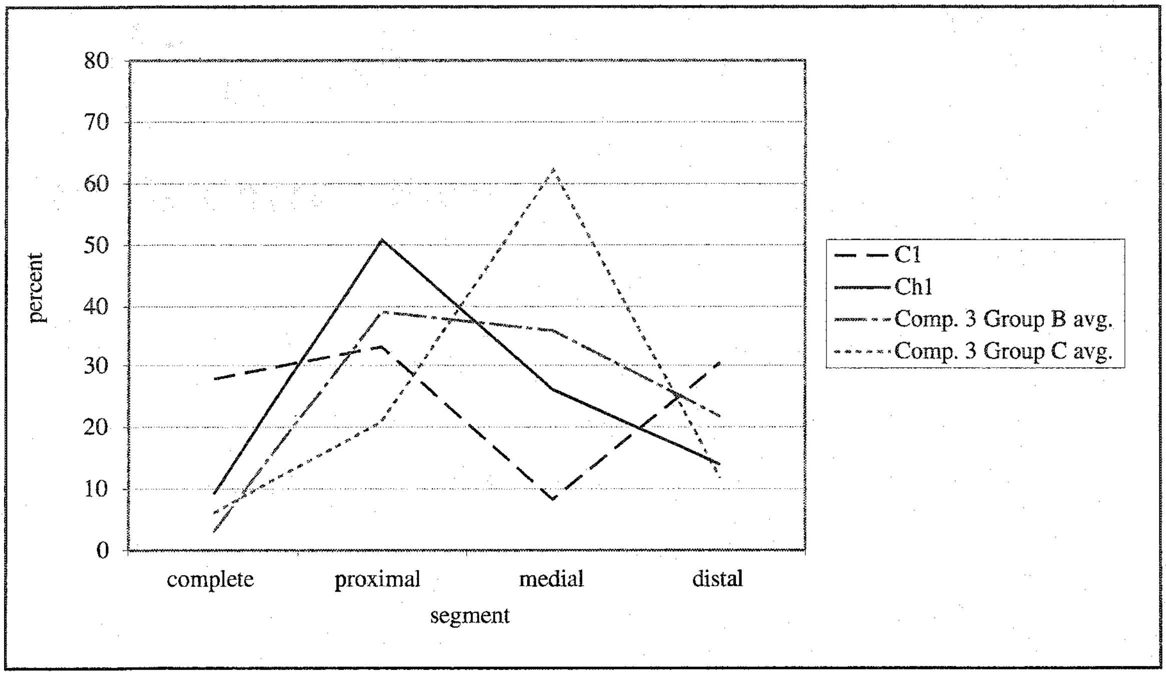

Figure 7.15 Component 2 microblade segmentation by material type and Component 3 microblade group averages.

Microblade modification

Analysis of microblade modification follows that for Component 3 microblades. A total of 13 microblades exhibited some type of secondary modification (12.4% of all Component 2 microblades). Modification for Component 2 consists of end modification (n=4, 31% of modified microblades), lateral retouch (n=5, 38%), and lateral minor damage (n=4, 31%). Modified and unmodified microblades were tested for differences in metric and discrete variables (see Table 7.4). As discussed above, no significant differences were apparent for metric variables like length, width, thickness, T/W index, and modified weight.

Modified microblades are represented by relatively greater frequencies on medial and lesser frequencies on distal and proximal segments[7]. This pattern is similar to that observed for Component 3 microblades. Coefficient of variation values suggest that modified microblades are more standardized with respect to length, proximal thickness, and modified weight (Table 7.6). End modified microblades have low variability in length and proximal thickness, suggesting these may be criteria for utilization. Laterally modified microblades have low cv values for proximal width and thickness, supporting the notion of use as lateral insets into composite tools. Given this small sample, further analysis of the type conducted for Component 3 microblades is probably unwarranted.

Table 7.6 Coefficients of variation for metric variables of Component 2 microblades by modification type.

Variable	*Un-modified*	*Modified*	*End mod.*	*Lateral (all)*	*Lateral minor*	*Lateral retouch*
Length	66.9	48.4	36.3	49.3	44.3	59.2
Proximal width	26.5	32.7	56.5	22.0	9.3	29.8
Proximal thickness	41.7	27.3	33.3	27.3	20.0	25.0
L/W index	54.7	63.1	91.7	45.4	46.8	49.4
T/W index	31.1	38.8	61.5	22.0	22.2	14.1
Modified weight	154.5	85.7	128.6	100.0	80.0	87.5

Burin spalls (n=8)

Eight burin spalls were found in Component 2 (Figure 7.16). Though they are both characterized as linear flakes, burin spalls clearly have different morphological characteristics than microblades (see above). Component 2 burin spall proximal thickness/proximal width ratio is 62±15 compared with 24±8 for microblades (n =8 burin spalls, 105 microblades), significantly thicker (Mann-Whitney U=4, p=0.0001) (see Figure 7.17). Component 2 burin spalls are morphologically similar to those from Component 3, and technological and functional interpretations are discussed below in that section.

Unifaces (n=1)

One uniface was recovered from Component 2 (Figure 7.18).

UA2003-54-1302, short-axis beveled flake

This specimen was manufactured from a flake or a blade of gray chert (C1) measuring 8.0 mm long, 13.1 mm wide, 3.0 mm thick, and weighing 0.2 g (Figure 7.18). Classed as a short-axis beveled flake, it has a convex working edge shape, with unifacial retouch and damage extending for 10.3 mm across the distal end of the flake and 10.0 mm edge diameter. The cross section of the specimen at its working edge is plano-convex. The thickness of the specimen at its

[7] χ^2 test result: segmentation by modification presence, χ^2=9.09, df=3, p=0.028

Figure 7.16 Component 2 burin spalls.

working edge is 2.53 mm, and the angle of utilization is approximately 60°. Minute flake scars (a few with hinge terminations) are evident on the working edge.

<u>Modified flakes (n=3)</u>

Three modified flakes were recovered from Component 2 (Figure 7.18).

UA99-62-531, modified flake

This specimen is a medial flake fragment of brown jasper (J2) measuring 13.6 mm in length, 20.3 mm in width, and 3.3 mm in thickness, weighing 1.0 g (Figure 7.18). Edge damage is evident on the left lateral ventral edge (for 11.8 mm) and right lateral dorsal/edge (8.2 mm). Burin-like wear is evident on the proximal edge for 18.4 mm in length. The working edge angle

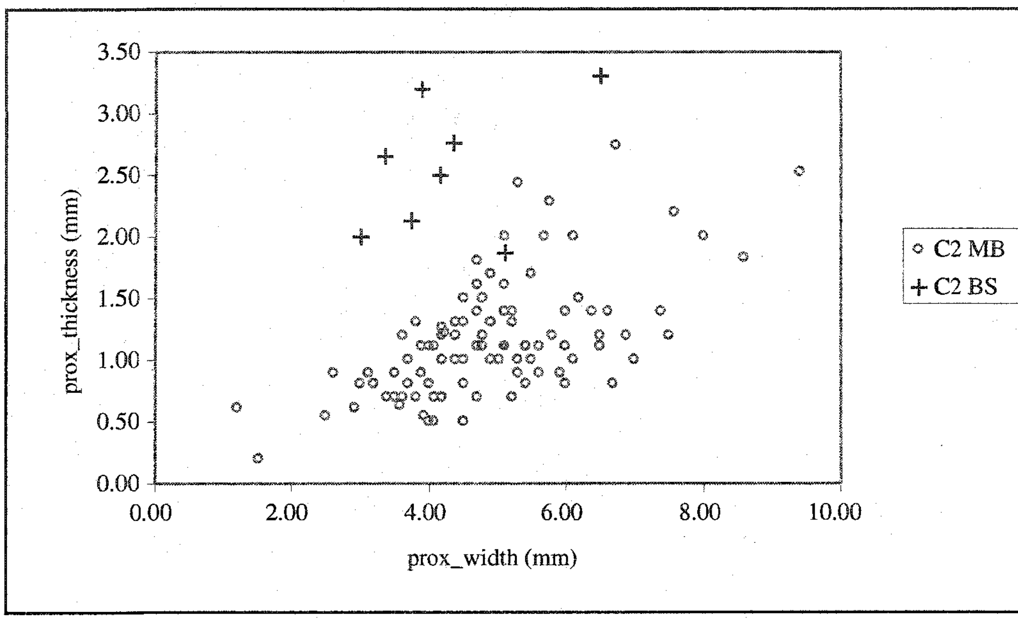

Figure 7.17 Component 2 burin spall and microblade width and thickness.

is 80° for the burin-like wear and 20° for the edge damage. No burin scar is evident, and the burin-like wear is on the snapped proximal end.

UA2003-54-1308, modified flake

This specimen is a distal flake fragment of gray chert (C1) measuring 8.8 mm long, 17.0 mm wide, 3.0 mm thick, and weighing 0.2 g (Figure 7.18). Microflaking is evident on the right lateral-dorsal edge, at an edge angle of 30° for 5.0 mm.

UA2003-54-1315, modified flake

This specimen is a complete flake of gray chert (C1) measuring 17.5 mm long, 20.2 mm wide, 2.2 mm thick, and weighing 0.8 g (Figure 7.18). Minor edge damage is present around the periphery of the flake, 13.2 mm along the left lateral-ventral edge, 11.3 m along the right lateral-ventral edge, and 3.5 mm along the distal-dorsal edge. Edge angles are between 20· and 30°.

Spall Scraper (n=1)

One spall scraper was recovered from Component 2, within the eastern area (Figure 7.18). General discussion of this artifact type is presented under Component 3 spall scrapers (see below). This specimen, UA2003-54-1199, was very similar to those recovered from Component 3. The dimensions are 64.4 mm x 92.7 mm x 12.0 mm, and it weighs 83.6 g, in the middle of the Component 3 spall scraper range. Damage consists of wear to the distal edge in the form of

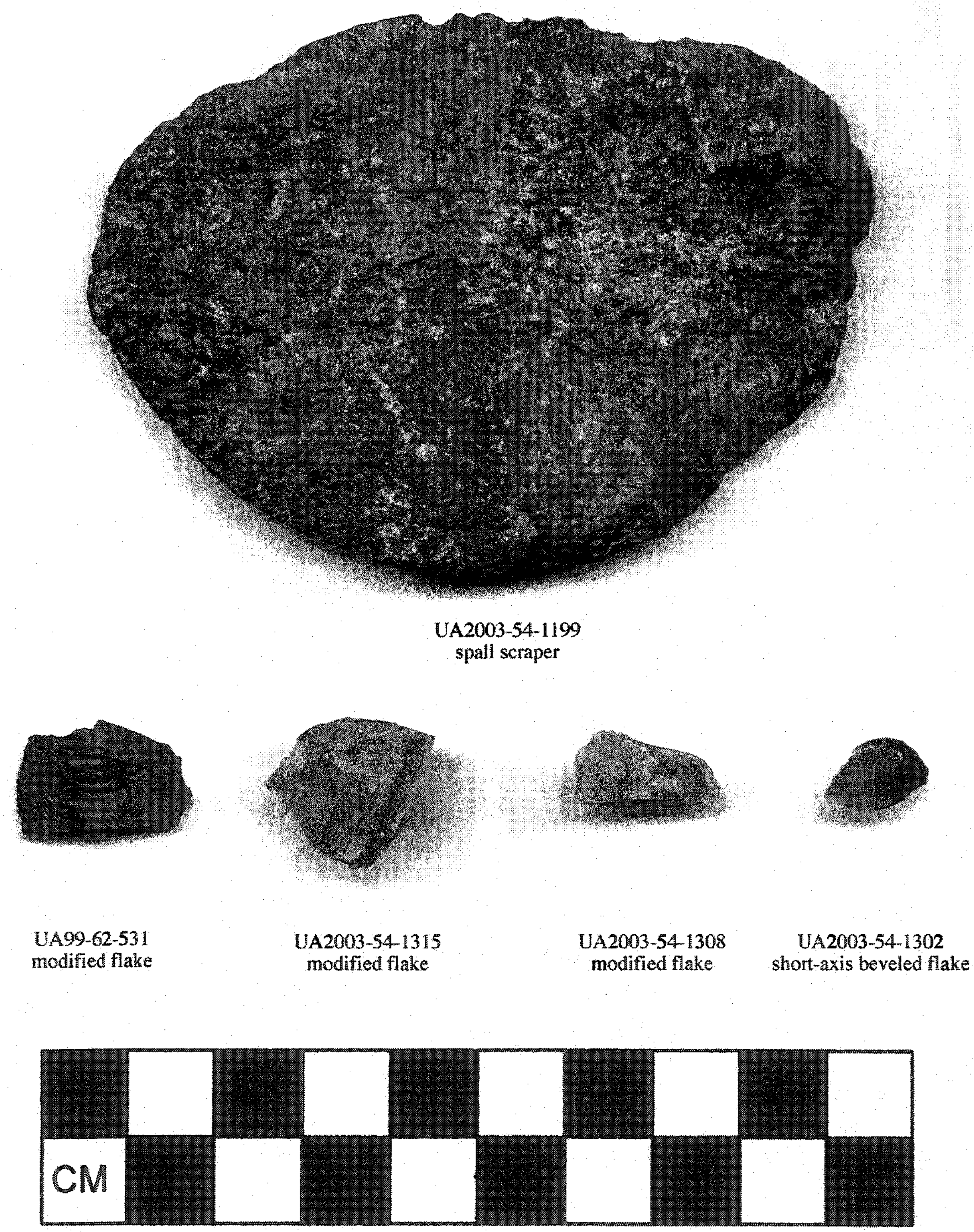

Figure 7.18 Component 2 modified flakes, spall scraper, and short axis beveled flake.

removal of small chips and crushing damage. Some polish is evident on all edges, and striations occur oriented perpendicular to the distal edge. This wear pattern is consistent with scraping both resilient and soft material with the distal end, and perhaps cutting/scraping softer material with all edges with a motion along the axis of the spall. The angle of the utilized distal edge is a relativly uniform 25°. The angle of use is consistent with that of the Component 3 spalls. Reddish residue (probably red ochre) is apparent within cracks in the material on both dorsal and ventral faces.

Cobble manuport (n=8)

Eight cobbles were recovered from Component 2, seven associated with Feature 19 (a circular cobble cluster) and one hearthstone associated with hearth Feature 17 (Figures 9.6-9.8). The cobbles are all angular granite, and probably derived from the local bedrock. Maximum dimension ranges from 6.3-16.0 cm (averaging 111.4±40.9 cm), minimum dimension ranges from 1.2-7.8 cm (averaging 48.4±21.4 cm), and weight ranges from 28.7-1697.1 g (averaging 527.2±593.1 g). None have observable damage. Two of the seven cobbles (UA2003-54-1295 and 1297) have surfaces that may be thermally altered (reddened). UA2003-54-1201, 1202, and 1218 are crumbling and have many cracks throughout the material, and could be considered degraded granite. The hearthstone associated with Feature 17 measures 10.1 cm by 7.3 cm by 4.8 cm and weighs 285.0 g, and is thermally altered.

Unmodified flakes (n=705)

A total of 705 unmodified flakes, flake fragments, and shatter (angular debris) were recovered from Component 2, weighing 33.3 g (averaging of 0.05 g/flake). Detailed debitage analysis is presented in Chapter 8. Table 7.7 lists number of flakes by material type. Component 2 is made up of two widely separated activity areas (12 meters), and material type representation is different for both areas. Area E is composed primarily of light brown chalcedony (Ch1) and reddish chalcedony (Ch2), whereas Area F is composed primarily of beige quartzite (Qa1), though both have small quantities of gray chert (C1).

Table 7.7 Component 2 flake totals by material type.

Mat.	*N*	*%*	*Wt (g)*	*%*
Qa1	329	46.67	11.79	35.41
Ch1	295	41.84	14.47	43.45
Ch2	39	5.53	3.18	9.55
R2	25	3.55	3.31	9.94
C1	16	2.27	0.52	1.56
Qa2	1	0.14	0.03	0.09
TOTAL	705	100.00	33.30	100.00

Component 3 Artifacts (~8900 BP, ~10000 cal BP)

Component 3 artifacts include 7,132 individual lithic artifacts. Of these, 257 (3.6% of total items) are secondarily modified, with 177 formal tools and 80 expedient tools (see Figures 7.19 through 7.49). Artifacts by category include 2 microblade cores, 3 microblade core fragments, 18 microblade core tablets, 9 microblade core facet rejuvenation flakes, 134 modified microblades, 3 burins, 32 burin spalls, 6 unifaces, 2 bifaces, 67 modified flakes, 11 spall scrapers, one hammerstone, one chopper/spall core, 17 manuport cobbles, 1,210 unmodified microblades, and 5,591 unmodified flaking debris. In addition to the lithic artifacts, a worked mammoth ivory rod or point and a number of ochre fragments were recovered within Component 3.

Microblade cores (n=2)

Two complete microblade cores have been recovered from Component 3 (Figures 7.19 and 7.20). The cores are made on fine-grained material, one of black chert, and one of gray chert. Both of these cores were manufactured on thick flake or core blanks. No bifacial preparation was evident. Both cores are subconical, and do not show typical wedge-shaped microblade core treatment such as bifacial reduction or fluting on one end. Each is discussed separately below.

2002-62-325, microblade core

This specimen is a conical microblade core of black chert (C4), weighing 14.3 g (Figures 7.19 and 7.20). The general morphology of the core is conical, given microblade removals around almost the entire circumference of the platform, however there is a distinctive back element still present. Thus, for this description, the front will refer to the fluted face opposite this back. This piece was likely manufactured from a nodule or chunk of chert, as no evidence of a

Figure 7.19 Component 3 microblade cores.

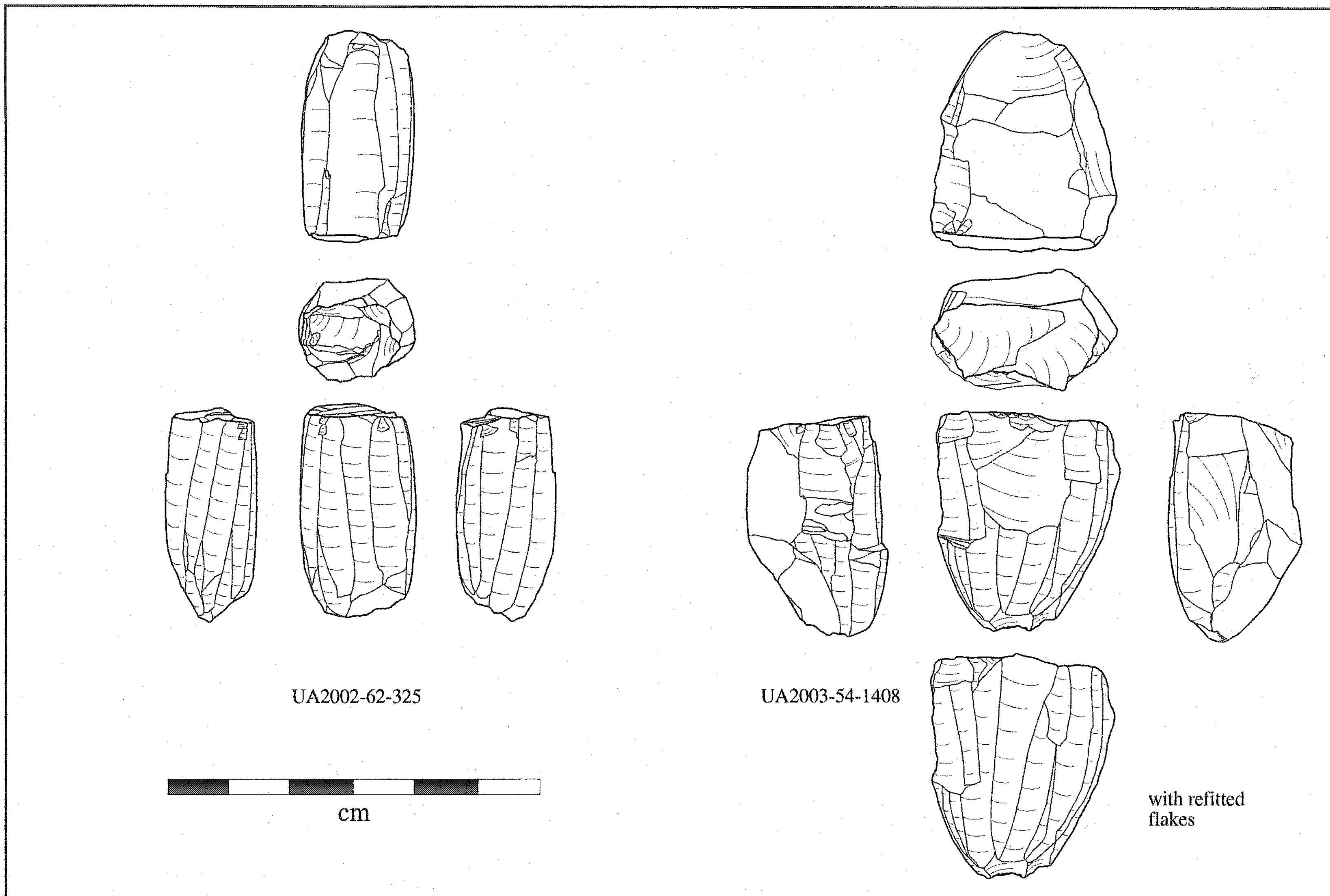

Figure 7.20 Component 3 microblade core line drawings.

flake blank is apparent. Core height is 34.6 mm, maximum core width from side to side is 18.6 mm, and maximum core length front to back is 14.3 mm.

The platform is oval and measures 14.75 mm (side to side) by 12.95 mm (front to back). The platform exhibits a series of hinge fractures about 3.7 mm from the front fluting edge. The platform was formed through the removal of several flakes from the front and both sides, with a platform angle between 90-95°. Microblades were struck from the present intact platform, evidenced by 7 negative bulbs of force adjacent to the platform. The microblade flutes extend from the platform to the bottom of the core. The longest microblade flute length is 32.34 mm. There are a total of 12 microblade flutes as enumerated from parallel arrises halfway down the fluting face. Microblades were struck from nearly the entire periphery of the core, with a back element (appearing more rough and weathered than the microblade flutes) measuring 8.2 mm at the platform edge, widening to 11.2 mm halfway down the back of the core. Microblade flute width measurements were taken 1.5 mm below the platform edge, to be comparable to microblade width measurements (see below). Flute width ranges from 1.5 to 5.5 mm, with a mean of 3.74±1.30 mm. However, when only those flutes with negative bulbs of force present are included, the mean is 4.36±0.78 mm. Of the 12 flutes, only one has a hinge fracture (7 mm below the platform edge).

The base of the microblade core displays a keel-like morphology, oriented side to side rather than front to back, as in many wedge shaped core specimens. The keel was bifacially thinned. Crushing wear is evident on the back of the keel edge, and polish can be seen on the keel edge, suggesting a base or clamp was used in the utilization of this core.

Only three complete microblades of this material type were found in Block Y (UA2003-54-757, 821, 905). The latter two were refitted to this core, and the first one almost certainly was struck from this core. The two microblade widths are 4.4 mm (UA2003-62-821) and 6.7 mm (UA2003-62-905).

2003-054-1408, microblade core

This specimen can be classed as a subconical microblade core of gray chert (C1), weighing 25.3 g (Figures 7.19 and 7.20). The general morphology suggests an intermediate form between a classic "tabular core" and a subconical core, similar to UA2002-62-325, described above. This piece was manufactured from a nodule or chunk of chert, and no evidence of a flake blank is apparent. The specimen is much thicker than a typical tabular core, though it exhibits an unretouched back and right side where no microblades could be detached. The left side does exhibit numerous hinge fractures where microblades were detached, and microblade flute scars below the hinge fracture area. For this description, the front will refer to the fluted face opposite the back. Core height is 35.7 mm, maximum core width from side to side is 30.1 mm, and maximum core length from front to back is 18.6 mm.

The platform is plano-convex to almost rectangular, with the long flat portion adjacent to the back of the core, two short sides, and a convex fluting front. The platform measures 25.9 mm from side to side and 14.1 mm from front to back (maximum dimensions), with a platform angle of 90°. The platform surface is relatively free of imperfections, hinge fractures, and exhibits two large flake scars covering almost the entire surface, perhaps remnants of platform rejuvenation flakes (core tablets). The last core tablet was struck sideways to the short axis of the piece (i.e., front to back). Microblades (or more specifically flakes) were struck from the present platform (with flakes attached, see below), evidenced by 2 negative bulbs of force adjacent to the platform. The microblade flutes extend from the platform to the bottom of the core. The longest microblade flute length is 34.41 mm. A flake was removed from fluting face of the core, 14.0 mm in width and 19.5 mm in length, and two adjacent flakes were removed from either side of the first flake, further obscuring the total flute count. All three of these flakes were recovered in the vicinity and refitted onto the core. Another series of flakes were removed from the left side of the specimen, terminating in numerous hinge fractures. These flakes were not recovered. If the knapper had removed those hinges and continued to produce microblades on this side, this specimen would more closely resemble the other complete core found in Area D (UA2002-62-325).

When the flakes are refitted, 8 flutes can be reconstructed, and only these are used in computing flute widths. When all flutes appearing near the base of the core are counted, a total of 11 flutes can be discerned. Microblades were struck primarily from the front and left side of the core. Flute width ranges from 2.4 to 8.2 mm, with a mean of 4.38±1.78 mm. Five complete microblades of this material type were found in Block Y, and none of them could be refitted to this core, although there are several that are undoubtedly the same material type and likely came from this core.

The base of the microblade core is unifacially retouched on the front, resembling endscraper retouch. This retouch consists of microflaking and fine crushing and may relate to clamping. This specimen, while reminiscent in general morphology to tabular cores, is clearly not a Tuktu tabular core, which are characterized by rectangular shapes (non tapering) and flat faces (Campbell 1961; Cook 1969). The front fluting face is moderately convex and microblade removals occur on the right side and may have occurred on the left side (as evidenced by the numerous hinges halfway down the fluting face). Furthermore, core tablets are not generally found in association with tabular cores; whereas they are prevalent in this component. Given these data, this specimen is interpreted as a relatively idiosyncratic piece largely shaped by defects in the material.

Microblade core forms can be generalized on the basis of the two complete cores of gray chert and black chert, 18 core tablets (12 of gray chert, 3 of tan-mottled chert, 1 of black chert, and 2 of gray rhyolite), and 9 facet rejuvenation flakes (3 of gray chert, 3 of black chert, 2 of tan-mottled chert, and 1 of argillite). Both cores were produced from large flakes or cobbles (no cortex was seen on either specimen). There does not appear to be extensive effort in shaping the cores toward a specific form. The bases do not appear to have been extensively shaped, though unifacial retouch of the keel in UA2003-054-1408 is evident. The presence of facet rejuvenation flakes or microblade overshoots with keel remnants (see below) suggests that wedge core forms were present, which did see shaping of the keel element. Microblades were produced through unidirectional blade removal. No primary ridge spalls or ski spalls were found that would indicate the presence of bifacial core preforms. These cores were made on thick flakes or cobbles.

Platform surfaces are horizontal and perpendicular to the fluted face(s). Platforms were prepared by both large flakes struck perpendicular to the fluted face that removed most or all of the platform, and by multiple smaller flakes struck perpendicular to the fluted face from multiple directions. These rejuvenations removed thick flakes generally with remnant flutes at the proximal end, though sometimes these were difficult to observe due to crushing or damage on platform edge.

Core fragments such as platform rejuvenation tablets and facet rejuvenation flakes can be used to reconstruct core types. Core tablets (see below) exhibit shapes ranging from rectangular to oval, and none exhibit typical elongate wedge-shaped core tablet forms, however, fluting face shape is convex and diameters average 19.39±7.21 mm (7.2-30.2 mm), consistent with the two core measurements (30.1 x 18.6 mm and 18.6 x 14.3 mm). The argillite, tan-mottled chert, and one of the gray chert facet rejuvenation flakes possess keel remnants similar to wedge shaped microblade cores. All exhibit some form of microflaking or crushing damage, and one contains polish damage on the keel edge. The two tan-mottled chert specimens came from the same area

(Subarea B4), and probably the same core, as the area is dominated by microblades of this material type. One gray chert and two of the C4 facet rejuvenation flakes that refit possess keels suggestive of square or flat bottom elements, similar to the UA2003-54-1408 gray chert core; the former probably was an earlier detachment from this core. The remaining two facet rejuvenation flakes are too fragmentary to aid in reconstruction of core type. Given these data, both wedge shaped and subconical cores can be posited. Linking specific core types with material type is difficult, but given the localized distributions of argillite (within Area A) and tan-mottled chert (within Subarea B4), these microblades are hypothesized to have been produced by wedge-shaped microblade cores. In all likelihood, a number of cores were likely used to produce the gray and black chert microblade specimens, and further delineation cannot be supported.

There are very few formal typologies of Alaskan microblade cores (see Mauger 1972). Clark (2001:76-77) differentiates between wedge shaped cores with and without Campus type platform preparation, core-burins (multi-facetted burins), tabular cores, and geometric cores (which include conical, cylindrical, pyramidal, cuboid, tetrahedral, and scalene). Cook differentiated three major types of microblade cores at Healy Lake: Campus cores (wedge shaped), tabular cores, and "plain or simple," exhibiting a conical morphology with platform and basal elements with microblade flutes around the platform periphery, and specimens that are intermediate (Cook 1969:116).

While wedge shaped microblade cores have received detailed analyses over the last thirty years (Yoshizaki 1961; Sanger 1968; Hayashi 1968; Cook 1968, 1969; Kobayashi 1970; Mauger 1972; Powers 1983; Flenniken 1987), other core types have received somewhat less attention. A number of researchers distinguish tabular (or Tuktu) cores, but the remainder of the quite variable Alaskan microblade core record is generally folded into a conical or subconical, conoidal or subconoidal, polyhedral, prismatic or geometric, aberrant, or amorphous categories (West 1981:87-93; Ackerman 1996c:429; Clark and Gotthardt 1999:114-118). A canvas of the literature reveals that there are a number of cores from eastern Beringia similar to those recovered at Gerstle River (see Table 7.8).

Table 7.8 Conical microblade core data for Interior Alaska morphologically similar to Gerstle River Component 3 specimens.

Component	*Specimen (catalog number or figure reference)*	*Associated date*	*Reference*
Healy Lake Village (XBD-020)	Plate 18, nos. 4, 5, 27, 30, 31 (RaEc-1-446) (1969:351)	Various	Cook (1969)
Healy Lake Garden (XBD-204)	Figure 26, no. 1 (1969:262b)	1260±90 BP 1270±80 BP	Cook (1969)
Lake Minchumina (MMK-004) Levels 4-5	UA73-79, 191, 290, 443	4800-1900 BP	Holmes (1986)
Swan Point (CZ2)	Holmes 1996:322b	7400±80 BP	Holmes et al. (1996)
Panguingue Creek C2	UA85-80-279, 1996:370d)	8170±120 BP, 9836±62 BP, 9850±140 BP, 10180±130 BP	Geobel and Bigelow (1996); Pontti (1997)
Whitmore Ridge C1 (XMH-72)	1996:389a, b, c (AMU67-2-2967, 2968, 2969, 3204)	9890±70 BP, 9600±140 BP, 9830±60 BP, 10270±70 BP	West et al. (1996c), West (1972:12); Zinck and Zinck (1976:B20)
Tangle Lakes	West 1981:116, no. 1	Unknown	West (1981:116)
Ilnuk Site	1996:468d	Undated	Ackerman (1996b)
Sparks Point	1996:400c (described as wedge shaped, but reduced from both ends, resulting in conoidal form)	9060±425 BP 9200±60 BP 9110±80 BP	West (1996)
Kagati Lake (GDN-093)	Larger cores (multiple types)	Undated	Gallison (1983)
Birch Lake	M 518	Undated	Skarland and Giddings (1948)
MLZ-061 (RkIg-47)	Plate 9A, Figure 4.1b (1993:102-106, 285)	Undated	Clark and Clark (1993)
HEA-018	Conical cores (and biface fragments, retouched flakes)	Undated	Holmes (1975b)
HEA-030	Conical core with rotated platform (retouched flake, biface fragment)	Undated	Holmes (1975b)
Clearwater Lake 2 (XBD-086)	Conical core (projectile point tip)	Undated	Yarborough (1975:9)

There are at least two interpretations of conical cores with respect to cultural traditions and derivation. Ackerman (1992) and others (Anderson 1980; West 1996) see some conical forms, such as those at Kagati Lake and Anangula as deriving from the Sumnagin Tradition, an early Holocene Siberian cultural group (see West 1996:550-551). Clark and Gotthardt (1999:116-117) view these forms as rather "unspecialized in format" and representing *in situ* development in Alaska. West (1981:88, 122-123), Clark (2001:76), and Ackerman (1996d) view conical cores found in Denali Tradition sites as a rare variety of wedge shaped microblade cores. The co-occurrence of conical and wedge shaped microblade cores at Lake Minchumina, Healy Lake, Swan Point CZ2, and Whitmore Ridge would support this notion (Holmes 1986; Cook 1969; Holmes et al. 1996; West et al. 1996c). The data from Gerstle River Component 3 suggest that both conical and wedge shaped forms were present. Very little separates the UA2002-62-325 core from a wedge shaped microblade core manufactured on a flake with microblade removal on both "sides" and back of the core. This supports the hypothesis that at least some conical forms in Interior Alaska are a form of wedge shaped cores with microblade removals from the sides (and back) as well as the front face.

While the two complete microblade cores recovered from Component 3 are clearly not wedge shaped, the smaller core (2002-62-0325) does have keel characteristics common to wedge cores. Hayashi (1968:178) notes that some semi-conical and conical forms in Asia were transformed from wedge shaped microblade forms. Conical cores share some similarities with tabular cores (generally found after 5,000 BP), such as a flat and unformed back, however tabular cores rarely have associated core tablets, and the presence of core tablets and fluting on the sides illustrate the technological differences between the conical cores at Gerstle River Component 3 and tabular cores, especially Tuktu varieties.

Cores similar to both complete specimens found at Gerstle River Component 3 are present in the Healy Lake Village site collection (Cook 1969). UA2002-62-325 is similar to double-ended cores (Cook 1969: Plate 18, nos. 4, 5, 30, 31). UA2003-54-1408 is similar to larger semi-conical varieties (Cook 1969: Figure 16, no. 1, Figure 26, no. 1). Other similar cores are listed in Table 7.8. Most of the sites are of Late Pleistocene – Early Holocene age, but several are from the mid-Holocene or later, suggesting that this form is best considered as one of a variety of core forms used throughout this period in Interior Alaska.

Microblade core manufacturing systems have been described for wedge shaped cores (see references above), but only Hayashi (1968) explicitly describes the manufacture of conical cores similar to those found at Gerstle River Component 3. Classed as Fukui Type A semi-conical cores, preforms were in the form of cobbles, and remnant cortex was sometimes found on the ventral/distal ends of the cores (see 1968:170, Figure 3, no. 13). Retouch was crude or absent. Two types of core tablets were described Hayashi (1968), elongate, indicating the rejuvenation of a platform when the strike angle was too oblique or obtuse, and squarish, interpreted by Hayashi as formed by accident (due to fissures, hinging). Hayashi (1968:178) divides the Northwest Microblade Tradition (MacNeish 1964) into two phases, with wedge shaped cores in the earlier phase and wedge shaped (lacking side/edge retouch) often rotated to produce semi-conical and conical forms, and tabular cores in the latter phase. Gerstle River Components 2 and 3 appear to occur at this transition, with evidence of multiple core forms.

The Gerstle River Component 3 cores do not share many characteristics with tabular cores. Tabular cores do not contract at the base, have minimal retouch on the back and base, generally lack platform rejuvenation by means of core tablet removal, and are wide side to side, but narrow front to back (Campbell 1961; Cook 1969).

Microblade core tablets (n=18)

There are 16 microblade core tablets in Component 3, including a gray chert core tablet of 3 conjoined fragments (Figure 7.21). Two gray rhyolite core tablets refit and represent successive platform rejuvenation/preparation of the parent core. Material types include 10 gray chert, one black chert, three tan-mottled chert, and two gray rhyolite core tablets. Average length is 19.91±8.18 mm, average width is 19.61±6.72 mm, average thickness is 3.60±1.14 mm, and average weight is 1.3±1.2 g. Average number of flutes is 3.93±1.73, ranging from 1 to 7 flutes, and average widths are 3.60±0.7 mm. Tablet shapes range from rectangular to oval, with none exhibiting typical elongate wedge-shaped core tablet forms, best expressed at Dry Creek Component 2 and Campus site. The bulbs of force are generally very salient, and most of the core tablets exhibit premature hinge terminations, and thus do not represent the full extent of the parent core platform. Fluting face shape are almost exclusively convex suggesting wedge or subconical core forms. Fluting face arc diameter averages 19.39±7.21 mm, ranging from 7.16 to 30.17 mm. Platform angle ranges between 80° and 90°, with an average of 85±3°.

Of the platform tablets, three have evidence of successive refitted removals (see below), of gray chert, tan-mottled chert, and gray rhyolite. All were struck from different directions relative to the core platform; the gray chert specimens were struck from 180° opposite points; the tan-mottled chert specimens were struck about 90° apart, and the gray rhyolite specimens were struck from nearly the same direction, but about 20 mm apart. This is consistent with the two complete microblade cores, which show multi-directional platform rejuvenation scars. Only one of the specimens (UA99-62-110) exhibits modification subsequent to detachment, in that case, in the form of burin-like damage on the distal left lateral edge.

Seven microblade core tablets were recovered from Area B: four of gray chert (C1) in Subarea B2 and three of tan mottled chert (C7) from Subarea B3. Two of the core tablets refit in Subarea B3 (see below), and one core tablet (UA2001-71-1591) refits with another in Area D (UA99-62-11).

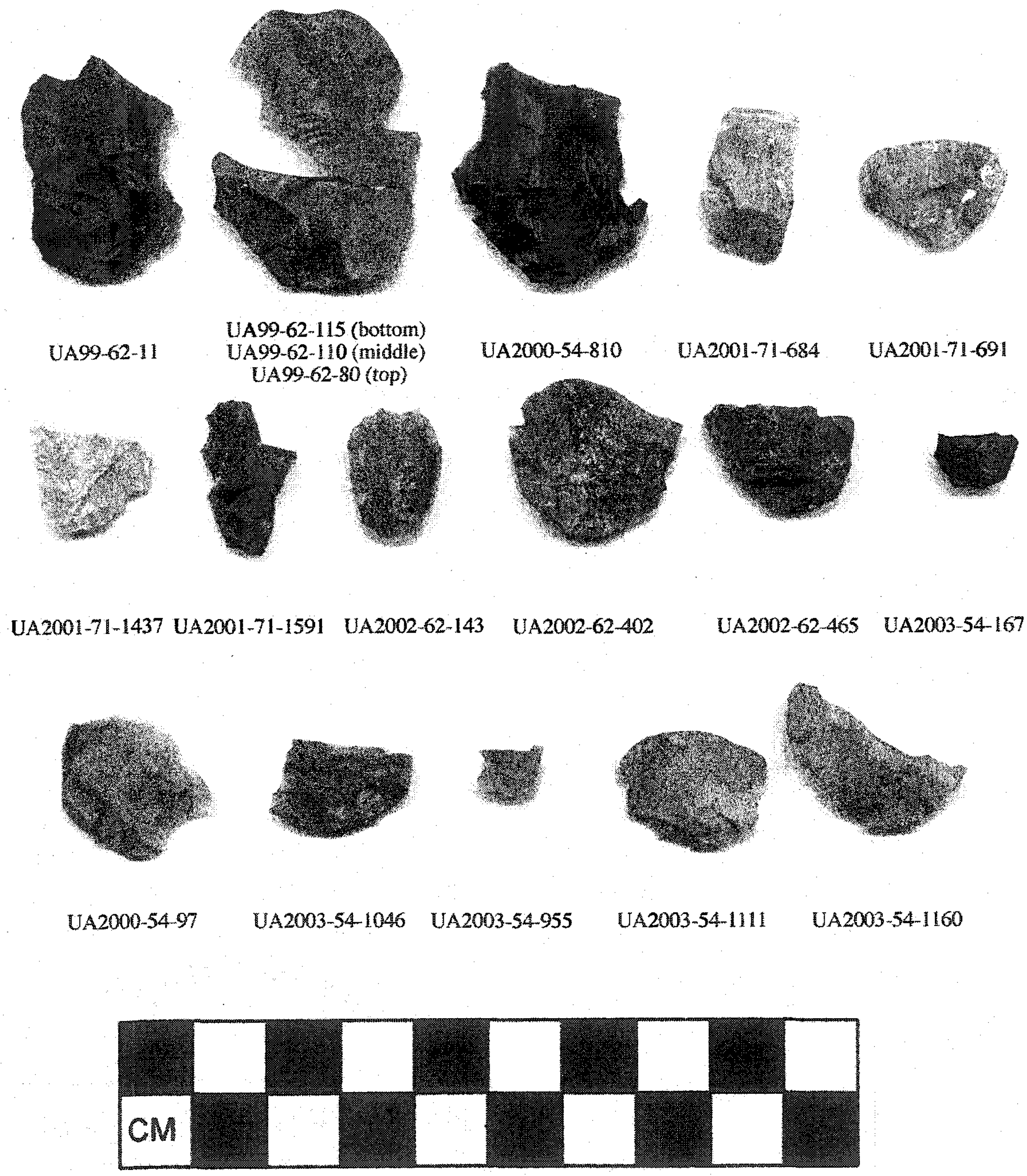

Figure 7.21 Component 3 microblade core tablets.

UA2000-54-97, gull wing flake

This specimen is a complete flake of gray chert (C1) measuring 20.30 mm long, 23.20 mm wide, and 3.06 mm thick, weighing 0.9 g (Figure 7.21). Three flutes are present, with widths of 3.70, 4.45, and 2.61 mm, with a mean of 3.59±0.93 mm. Two negative bulbs were observed on the proximal end (fluted face) and a few hinge fractures and light edge damage was present, thus the platform was used to detach microblades while attached to the core. Platform angle is 85°. Flake termination is feathered and probably represents a portion of the core platform.

UA99-62-110 (+UA99-62-80, 115), possible microblade core tablet

This specimen is a fragmented flake of gray chert (C1) measuring 17.71 mm long, 28.75 mm wide, and 5.12 mm thick, weighing 2.4 g (Figure 7.21). Two flake fragments refit to this piece, however two other fragments have not been refitted yet. The core tablet with the two refitted pieces measures 37.90 mm long and weighs 4.4 g. The missing fragments do not effect the total length and width measurements. Two, possibly three flutes are present, but difficult to discern due to material quality. Platform frontal edge based on edge damage is convex, with an arc diameter of 28.93 mm. Discernible flute widths are 5.46 and 2.5 mm, with an average of 3.98±2.09 mm. Hinge fractures are present on the dorsal surface and microflaking and crushing damage is evident on the core platform edge, and microblades were detached when attached to the core. Platform angle is 85°. Flake termination is snapped, and burin-like damage is present on the distal dorsal edge near the distal left lateral edge corner.

UA2000-54-810, microblade core tablet

This specimen is a complete flake of gray chert (C1) measuring 30.83 mm long, 27.30 mm wide, and 3.70 mm thick, weighing 2.5 g (Figure 7.21). Numerous parallel arrises are present along the proximal and proximal-lateral edges, forming an arc with a diameter of 22.90 mm, but width measurements from five prominent flutes are 5.83, 2.77, 2.56, 2.91, and 1.79 mm, with a mean of 3.17±1.55 mm. Multidirectional flake scars are evident on the dorsal (core platform) surface, and though some crushing damage was evident on the proximal edge, it is unlikely that microblades were detached while the specimen was attached to the core. Flake termination is feathered and probably represents a portion of the core platform.

UA2001-71-684, microblade core tablet

This specimen is a complete flake of tan mottled chert (C7) measuring 20.61 mm long, 12.83 mm wide, and 5.82 mm thick, weighing 0.9 g (Figure 7.21). No flutes can be directly measured. While hinge fractures occur adjacent to the platform edge, no microblades were detached while the specimen was attached to the core. This flake was detached from the parent core just prior to the removal of another core tablet (UA2001-71-691), and discussion of both specimens is provided below.

UA2001-71-691, microblade core tablet

This specimen is a complete flake of tan mottled chert (C7) measuring 14.90 mm long, 20.51 mm wide, and 4.30 mm thick, weighing 1.3 g (Figure 7.21). One definite flute is present, 4.01 mm wide, serving as the platform for this flake. Crushing and hinge fractures from previous core tablets are evident on the dorsal surface, though no negative bulbs are seen on the flute. While only one flute is clearly evident, the general morphology of the platform suggests a convex fluting face. This tablet refits with a previous core tablet (UA2001-71-684). Together, the length and width of the platform do not greatly change. The two flakes were struck from slightly different directions, with platforms located about 7.5 mm apart.

UA2001-71-1437, microblade core tablet

This specimen is a complete flake of tan mottled chert (C7) measuring 17.03 mm long, 17.35 mm wide, and 2.71 mm long, weighing 0.5 g (Figure 7.21). Four flutes are present, in an arc with a diameter of 17.10 mm. Flute widths are 2.97, 3.25, 4.22, and 4.64 mm, with a men of 3.77±0.79 mm. Crushing and hinge fractures are present but not as common as in other specimens, and microblades were detached while the platform was part of the parent core. Platform angle is 80°. Flake termination is snapped or stepped, so the measurements should be taken as a minimum of the original platform area. Minor edge damage is present on the proximal (ventral) and distal (dorsal) edges (both between 90-100° edge angles). Proximal damage extends 11.7 mm along a straight edge and distal damage extends 2.5 in the form of a weak convex point.

UA2001-71-1591, microblade core tablet

This specimen is a tabular complete flake of gray chert (C1) measuring 21.45 mm long, 13.41 mm wide, and 2.99 mm thick (at right lateral edge), weighing 0.5 g (Figure 7.21). Three flutes are present, with widths of 5.33, 5.37, and 2.46 mm, with a mean of 4.39±1.67 mm. Only one negative bulb is present (5.37 mm width), and the platform angle is 80°. This core tablet refits with UA99-62-11 (see below for discussion).

Five microblade core tablets were recovered from Area C, three of gray chert (C1) and two of gray rhyolite (R1). The two gray rhyolite fragments refit, but none of the gray chert specimens could be refitted. The two largest gray chert core tablets (UA2002-62-402 and 465) are similar in morphology, resembling typical core tablets from wedge shaped microblade cores, struck from the center of the convex fluted face. The remaining core tablet is harder to classify and may represent a side-struck core tablet (UA2002-62-143).

UA2002-62-143, microblade core tablet

This specimen is a complete flake of gray chert (C1) measuring 18.33 mm long, 13.19 mm wide, and 2.90 mm thick, weighing 0.7 g (Figure 7.21). Four flutes are present, in an arc with a diameter of 17.60 mm. The fluting edge is convex. Flute widths are 2.97, 2.77, 4.47, and 3.18 mm, with a mean of 3.35±0.77 mm. Crushing and retouch is evident on the platform edge, and microblades were struck from this platform. Platform angle is 90°. The platform dorsal surface exhibits a number of hinge and step fractures indicating flake removals perpendicular to the fluting face. Flake termination is feathered, but probably did not carry across the entire platform.

UA2002-62-402, microblade core tablet

This specimen is a complete flake of gray chert (C1) measuring 22.54 mm long, 23.72 mm wide, and 4.71 mm thick, weighing 2.3 g (Figure 7.21). Seven flutes are present, in an arc with a diameter of 23.67 mm. The fluting edge is markedly convex. Flute widths are 5.71, 5.93, 4.13, 6.71, 2.81, 5.70, 4.13 mm, with a mean of 5.02±1.36 mm. Crushing and retouch is evident on the platform edge, and microblades were struck from this platform. Platform angle is 85°. The platform dorsal surface exhibits numerous flake scars, hinge fractures, and damage resulting from flakes removed perpendicular to the fluting face. Flake termination is hinged, and core shape based on platform morphology was likely wedge or subconical.

UA2002-62-465, microblade core tablet

This specimen is a complete flake of gray chert (C1) measuring 15.95 mm long, 20.59 mm wide, and 3.64 mm thick, weighing 1.2 g (Figure 7.21). Six or seven flutes are present, in an arc with a diameter of 17.02 mm. The fluting edge is convex. Core shape based on the platform was likely wedge or subconical. Flute widths are 1.74, 5.00, 3.96, 1.22, 2.70, 4.53, and 3.30 mm, with a mean of 3.21±1.41 mm. Crushing and retouch is evident on the platform edge, and microblades were struck from this platform. Platform angle is 85°. The platform dorsal surface exhibits numerous flake scars, hinge fractures, and damage (much more than UA2002-62-402, resulting from flakes removed perpendicular to the fluting face. Flake termination is stepped, perhaps a result of material defects, and core shape based on platform morphology was likely wedge or subconical.

UA2003-54-1111, gull wing flake

This specimen is a complete flake of gray rhyolite (R1) measuring 15.99 mm in length, 20.06 mm in width, 4.13 mm thick, weighing 0.9 g (Figure 7.21). Two flutes are present. The general morphology is consistent with a convex fluting face (see below). Flute widths are 3.39 and 3.16 mm, with a mean of 3.18±0.02 mm. The platform is retouched and there are numerous hinge fractures on the platform surface indicating numerous preparation flakes struck perpendicular to the fluting face. Crushing and retouch is also evident on the platform edge, and microblades were struck from this platform. Edge angle is difficult to estimate given the numerous hinge fractures just behind the platform edge. Distal termination is hinged, thus the entire platform was not removed with this flake. When combined with refitted core tablet UA2003-54-1160, platform dimensions becomes 31.33 mm wide with a convex fluted face with an arc diameter of 23.51 mm. Average flute widths with the combined core tablets (n=4) is 3.24±0.10 mm, and platform angle is estimated at between 85 and 90°.

UA2003-54-1160, gull wing flake

This specimen is a complete flake of gray rhyolite (R1) measuring 26.34 mm in length, 19.74 mm in width, 2.32 mm thick, weighing 0.6 g (Figure 7.21). Two flutes are present. The general morphology is consistent with a convex fluting face (see above). Flute widths are 3.38 and 3.22 mm, with a mean of 3.30±0.11 mm. Crushing and retouch is evident on the platform edge, and microblades were struck from this platform. Edge angle is 85 to 90°. This core tablet refits with UA2003-54-1111 and combined data is provided above under that item.

Four microblade core tablets were recovered in Area D, one of black chert (C4) and three of gray chert (C1). The black chert tablet could not be directly refit to the black chert core from this area (UA2002-62-325), though it is likely related given its morphology. Two of the three gray chert core tablets appeared to be of different varieties (based on color and inclusions) than the chert core found in this area (UA2003-54-1408) and could not be refit to the core or to each other. UA2003-54-1046 is made from brownish gray chert, and UA2003-54-955 is made form a lighter gray chert variety. The third gray chert core tablet (UA99-62-11), found eroding from the bluff edge in Area D in 1999, is made from identical material to the UA2003-54-1408 core. Though it could not be refit to the core, it does give a good indication of the platform parameters at an earlier stage of reduction (see below).

UA99-62-11, microblade core tablet

This specimen is a tabular complete flake of gray chert (C1) measuring 30.88 mm long, 20.73 mm wide, and 4.05 mm thick, weighing 2.5 g (Figure 7.21). At least six flutes are visible, in an arc with a diameter of 30.17 mm, the two most prominent measuring 3.36 and 3.52 mm wide. Platform morphology is generally subrectangular to oval, with a straight edge on the right margin, and a convex fluted edge on the proximal margin. Microblades were struck from this platform when it was attached, and the platform angle is 85°. This matches closely the current platform on core UA2003-54-1408, though the absolute dimensions are larger. This flake is a good indicator of the platform dimensions of the parent core as the distal edge removed the back of the core platform. Numerous hinge and step fractures give evidence of flake removals perpendicular to the fluted faces. A thick beak-like projection on the distal end exhibits usewear retouch. A refitting core tablet (UA2001-71-1591) was found 6 m to the northwest. An earlier removal, this tablet was struck perpendicular to the present core tablet, removing about 25% of the latter's platform surface. The former tablet is important in that it retains platform edge crushing damage on its distal portion (i.e., the opposite face of microblade removals of the latter tablet). This suggests that microblades were struck from both almost the entire periphery of the core platform, excepting about 17 mm of the feathered right lateral margin (perhaps representing the back of the parent core). This would be consistent with the UA2003-54-1408 core specimen.

UA2003-54-167, microblade core tablet

This specimen is a short thick complete flake of black chert (C4) measuring 7.64 mm long, 11.59 mm wide, and 3.22 mm thick, weighing 0.2 g (Figure 7.21). Five flutes are present, in an arc with a diameter of 10.57 mm. The general morphology is consistent with a convex fluting face. Flute widths are 3.67, 1.08, 2.05, 3.02, and 1.71 mm, with a mean width of 2.31±1.04 mm. The platform is heavily retouched, with hinge fractures indicating previous retouch perpendicular to the fluted face. Crushing and retouch is evident on the platform edge, and microblades were struck from this platform. Platform angle is 85°. Distal termination is hinged, and platform size (other than minimum dimensions) cannot be reconstructed from this tablet. This core tablet is very likely from the microblade core UA2002-62-325 given the morphology, material, and provenience, but it could not be refitted to the core.

UA2003-54-1046, microblade core tablet

This specimen is a complete flake of gray chert (C1) measuring 15.69 mm in length, 21.12 mm in width, 2.07 mm in thickness, and weighing 0.4 g (Figure 7.21). Three flutes are present, with widths of 2.90, 3.78, and 4.78 mm, with a mean of 3.82±0.94 mm. Platform edge is convex with an arc diameter of 14.62. Flake termination is feathered, and the core rejuvenation flake does not appear to have removed the entire platform. The flake has a gull-wing morphology and may have been side-struck.

UA2003-54-955, microblade core tablet

This specimen is a complete flake of gray chert (C1) measuring 8.54 mm in length, 8.59 in width, 1.52 mm in thickness, and weighing 0.1 g (Figure 7.21). Two flutes are present, in an arc with a diameter of 7.16 mm. Flute widths are 3.15 and 3.00, with a mean of 3.08±0.11 mm. Crushing and retouch is evident on the platform edge, and microblades were struck from this platform. Platform angle is 85°. Flake termination is hinged, and platform size cannot be reconstructed from this tablet.

Microblade core facet rejuvenation flakes or microblade overshoots (n=9)

There are nine specimens classified as microblade core facet rejuvenation flakes in Component 3. Six of the nine flakes in this category are classed as microblades (for statistical analysis, see below), and three are not (UA99-62-100, UA99-62-650, and UA99-62-753) (Figure 7.22).

UA2001-71-325

This specimen is a microblade distal fragment of tan mottled chert (C7) measuring 13.77 mm long, 6.20 mm wide, and 2.98 mm thick (at the distal end), weighing 0.2 g (Figure 7.22). Three arrises converge at the distal end, and a fourth slightly above. The keel element exhibits light crushing on the right edge. Morphology suggests that it was detached from a wedge shaped microblade core.

UA2001-71-1435

This specimen is a microblade distal fragment of tan mottled chert (C7) measuring 25.14 mm long, 6.70 mm wide, and 3.46 mm thick (at the distal end), weighing 0.5 g (Figure 7.22). Three arrises converge at the distal end. The keel element exhibits light crushing on the right edge. Morphology suggests it was detached from a wedge shaped microblade core.

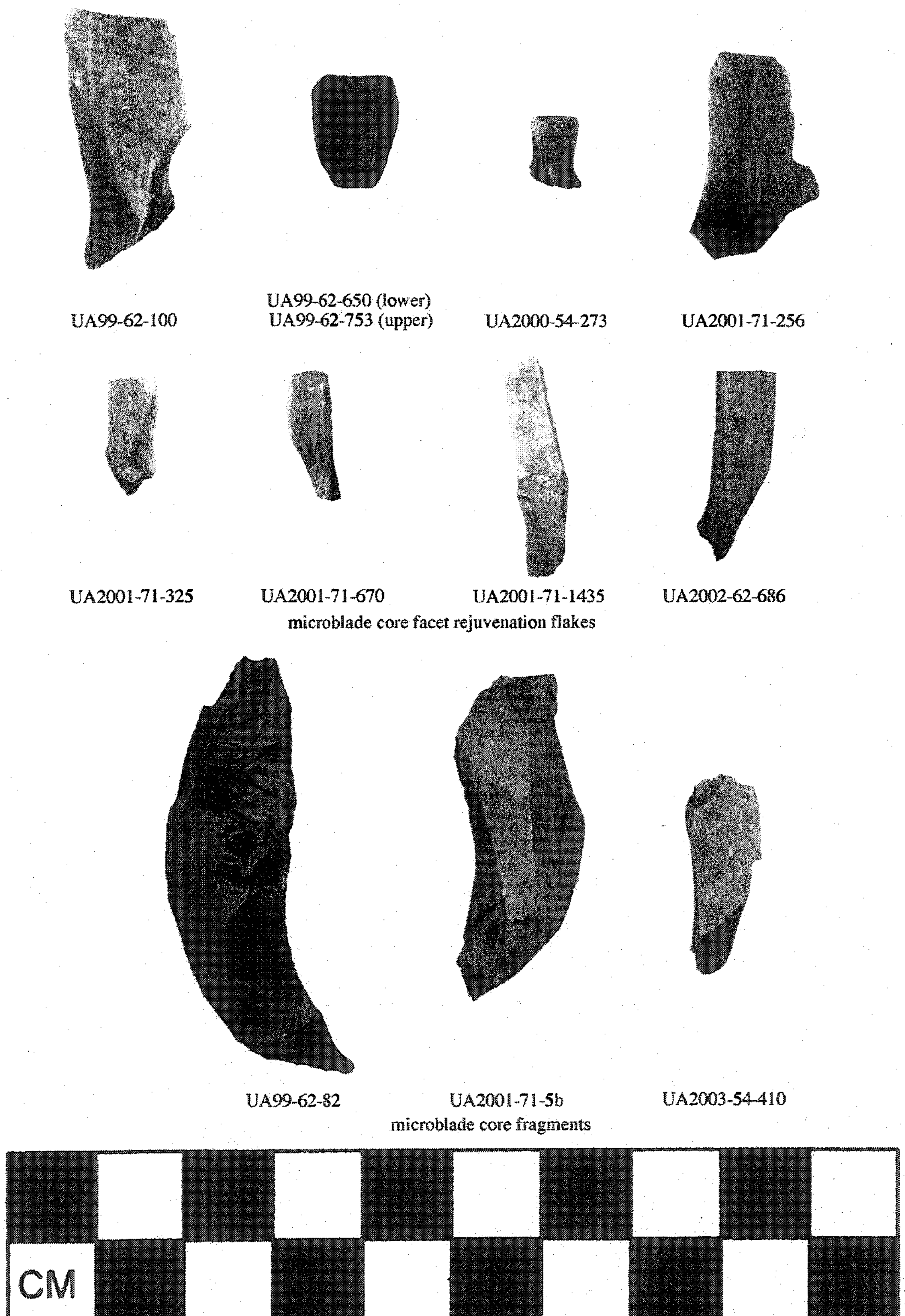

Figure 7.22 Component 3 microblade core facet rejuvenation flakes.

UA2002-071-686

This specimen is a microblade distal fragment of argillite (Ar) measuring 22.14 mm long, 7.39 mm wide, and 2.06 mm thick (at distal end), weighing 0.3 g (Figure 7.22). Four arrises are evident on the dorsal surface. The keel exhibits crushing, and overall form suggests detachment from a wedge shaped microblade core.

UA2001-71-256

This specimen is a microblade distal fragment of gray chert (C1) measuring 23.26 mm long, 9.89 mm wide at proximal end (15.76 mm wide at distal end), and 4.73 mm thick (at distal end), weighing 1.0 g (Figure 7.22). One arris is present. The keel is multifaceted and broad (14.89 mm wide) with crushing evident on the distal dorsal edge. Thus, this core fragment does not exhibit wedge core morphology, but is very similar to the bottom of the core UA2003-54-325 (see above). The material is also very similar (a homogeneous dark greenish-gray), and the ventral curvature is similar to the current fluted face of that core, suggesting it may be related.

UA99-62-100

This specimen is a distal blade fragment of gray chert (C1) measuring 28.76 mm long, 12.99 mm wide, and 5.90 mm thick (at the distal end), weighing 1.5 g (Figure 7.22). Previous blade scars are evident on the dorsal surface, converging at the keel. This may represent an early stage of microblade core preparation, specifically preparing the core face for microblade detachment. The keel has minor polish and grinding damage. The overall morphology suggests detachment from a wedge shaped core preform.

UA99-62-650 and 753

These two specimens are refitting fragments of a black chert (C4) microblade core. Together, they measure 12.66 mm long, 9.75 mm wide, and 4.84 mm thick (Figure 7.22). These flakes represent successive detachments from the bottom of the fluted face of a microblade core. These specimens appeared to be struck from the bottom of the core fluted face. Six straight arrises converge at the proximal end of these flakes. The small portion of bottom element present is not bifacially worked, but has two arrises, suggesting a square or flat core bottom element. Minor crushing damage is present on the dorsal proximal end near the platform for both flakes.

Two other specimens may be facet rejuvenation spalls (two of gray chert, one of black chert), as evidenced from keel remnants: UA2000-54-273 and UA2001-71-670. Mean size measurements for this group are 11.54±4.74 mm in length, 5.25±0.78 mm in width, and 1.59±0.19 mm in thickness. Both are distal fragments. In addition, a number of microblades and microblade fragments exhibit numerous hinge fractures below the platform, which may indicate their removal as part of a facet rejuvenation strategy aimed at the production of parallel-sided microblades.

Microblade core fragments (n=3)

Besides core tablets and facet rejuvenation flakes, there are other flake types indicative of microblade core production, maintenance, or microblade production. Primary ridged spalls (or crested blades) are often produced if the core was manufactured form a bifacial blank. The spall removed to initiate the platform will have a triangular cross section retaining the bifacial edge. None were found at Gerstle River. Another type of diagnostic debitage is primary spalls. Once the platform was prepared, early face removals prior to standardized microblade removals will exhibit unidirectional blade scars on the dorsal surface. Two specimens exhibit parallel blade scars and their morphology suggests that they were struck from wedge-shaped microblade cores, as portions of keel elements are present (Figure 7.22). A third flake is a tabular flake refit to one of the primary spalls.

UA99-62-82, microblade core primary spall or preform fragment

This specimen is a complete blade representing the frontal fragment of a black chert (C4) wedge shaped microblade core or core preform measuring 47.72 mm long, 16.07 mm wide, and 7.02 mm thick (at the distal end), weighing 5.0 g (Figure 7.22). Seven roughly parallel flake or blade scars are present on the dorsal surface, and there is a distinctive wedge-shaped distal portion, with microflaking retouch on the left distal edge. The size of the specimen, the lack of crushing or retouch in proximity to the platform, and the lack of microblade scars suggests that this specimen is a core face preparation flake prior to extensive platform preparation and microblade removal. Polish and very minor damage is present for 47 mm on the left margin and 13.6 mm on the distal-dorsal margin.

UA2003-54-410 and UA2001-71-5b, microblade core primary spalls or preform fragments

These two specimens are refitting frontal fragments of a gray chert (C1) wedge shaped microblade core or core preform (Figure 7.22). The first removal is a blade (UA2001-71-5b) recovered from disturbed contexts measuring 37.81 mm long, 13.51 mm wide, and 8.63 mm thick (at the distal end). This blade has two previous blade or microblade removals evident, and the keel exhibits bifacial retouch. The second flake is a tabular flake measuring 22.45 mm long, 8.43 mm wide, and 3.82 mm thick (at the distal end), weighing 0.4 g. The refit linked the earlier surface find to this component.

Microblades (n=1,350)

There are 1,350 microblade and microblade fragments in Gerstle River Component 3, 6 classified as microblade core facet rejuvenation flakes, 134 classified as modified microblades, and 1,216 classified as unmodified microblades (including 6 facet rejuvenation flakes). A representative sample of Component 3 microblades is presented in Figure 7.23, derived from Component 3 percentages of complete, proximal, medial, and distal segments, and relative frequencies by material type. Microblades make up 17.2% of all flaked stone lithics by count and 14.3% by weight. Total unmodified microblades weigh 92.2 g (11.7% of total Component 3 assemblage weight), and total modified microblades weigh 20.4 g (2.6%).

The microblades recovered from Gerstle River represent a distinct sample with respect to their utility within a technological system. It is important to note that unmodified microblades constitute debitage. Given the large sample of modified microblades, patterns of microblade selection for utilization as tools can be examined. Segment representation and inferred segment deletion can be informative in this regard. For the purposes of this description and analysis, microblade refits are ignored and each microblade is enumerated as individual fragments. Intrasite spatial microblade analyses (including refit analysis) and comparisons of Component 2 and 3 microblades are detailed in Chapter 8. Descriptive characteristics of the entire Component 3 assemblage are provided here, organized by metric variables, segment representation, arrises, raw material, and modification.

The excellent contextual control and large sample size of microblades in Component 3 allows exploration of structure in the data. The purpose of this section is to describe the microblades at Gerstle River Component 3 and to identify patterns among the data. The problem of equifinality must be assessed when interpreting differences in microblade continuous and discrete variables. For instance, a number of factors likely constrain size-related variables, and these are delineated within each section below. Description and discussion of microblades attributes are divided into microblade groups, metric variables, discrete variables, and modification.

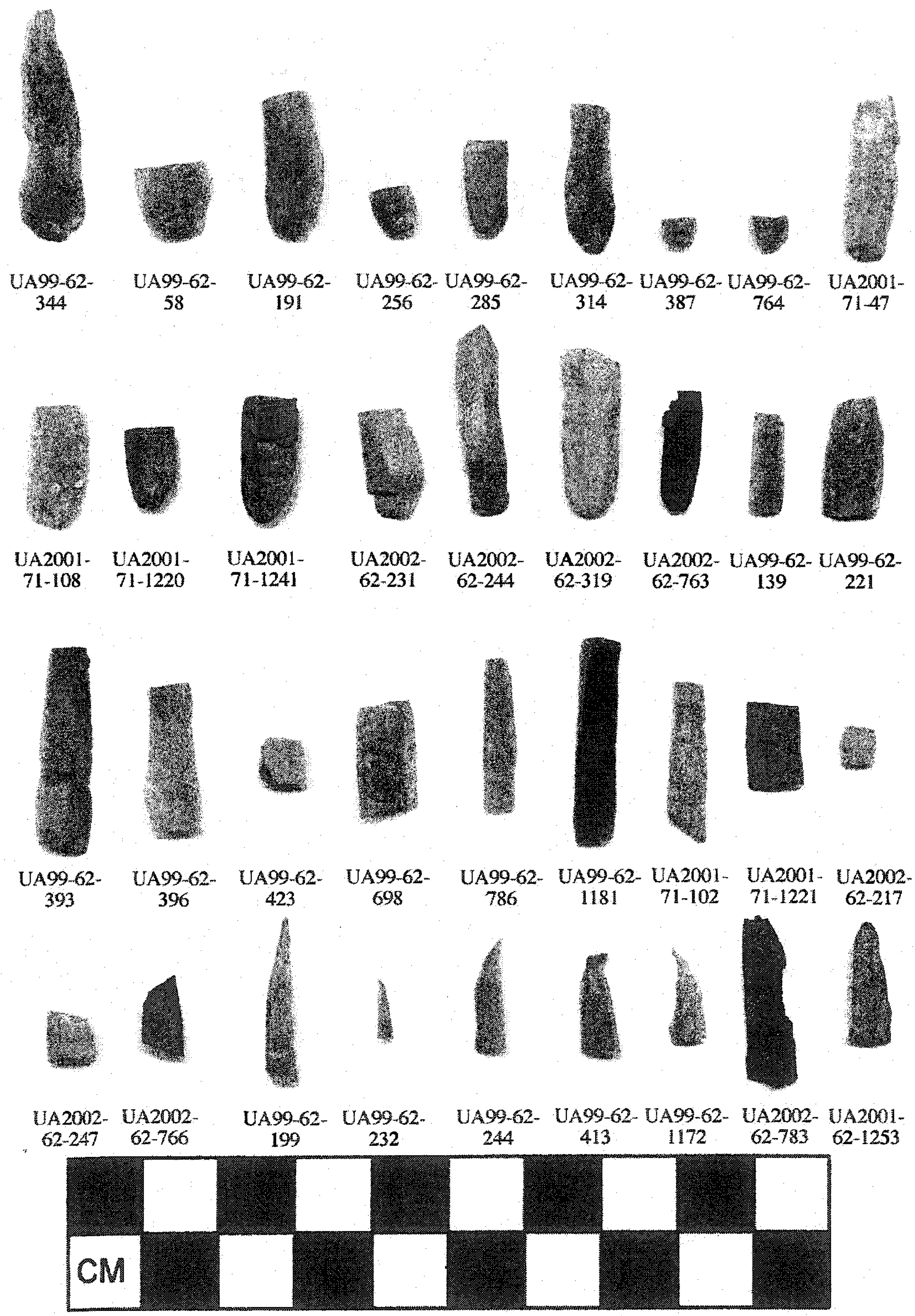

Figure 7.23 Component 3 microblades (representative sample for segment and material type).

Specific objectives are to (1) identify attribute differences between modified and unmodified microblades and among modification types in order to understand how and why microblades were selected for utilization; (2) assess patterns in material type suggesting different modes of manufacture or functional groupings (microblades brought on site vs. those manufactured on-site); (3) reconstruct core morphology for materials without representative cores; and (4) assess how certain attributes affect each other in order to assign meaning and to reduce the number of variables considered in future analyses.

Microblade Groups

Comparing modified and unmodified microblade percentages by material type yields three groups (Figure 7.24). Group A consists of An, C8, C9, Ch2, and R2 with 0% modified and low total numbers of microblades. Group B consists of Ar, C1, C4, C7, and R1 with 6-14% modified and constitutes the bulk of the microblade assemblage. Group C consists of C3, J1, and O with 25-39% modified, and are relatively rare. When these data are combined with the presence of core fragments (microblade cores, core tablets, and core fragments) by material type, Group B likely represents microblades manufactured and modified on-site and Group C likely represents exotic materials manufactured off-site and discarded on-site. The generally small sample sizes of Group A renders interpretation more difficult. The only material type in Group B that does not have microblade core parts is argillite, though this could be the result of the limited excavation in Area A ($9m^2$), where all of the argillite microblades were recovered. Material type C1 is likely composed of multiple material types (see above), and thus these sub-groups may lie closer to the remaining Group B material types in Figure 7.24.

Metric variables for each group are presented in Table 7.9. Microblades in Group B are wider and thicker than those in Group C (mean difference=0.7 mm), and A and C and A and B show no significant differences. Group B microblades tend to be the most divergent; they are slightly wider (5.9 mm vs. 5.3 for Groups A and C), thicker (1.4 mm vs. 1.3 for Groups A and C), and are heavier (0.08 g. vs. 0.06 and 0.07 for Groups A and C), though they have higher standard deviations (which probably relates to the larger ample sizes within Group B). The metric similarities of Groups A and C could indicate a relationship between the two in terms of technology or of organization within the site, however the similarities could relate to the much larger sample size of Group B. Group A microblades are considered to be made on exotic raw materials (with respect to the total assemblage) that are rarely found elsewhere in the assemblage. While no microblades in Group A show secondary modification, they may have been discarded at the site in a similar context as Group C microblades. The small sample size of Group A (n=23) and the lack of core parts of those raw materials makes further interpretation very tenuous.

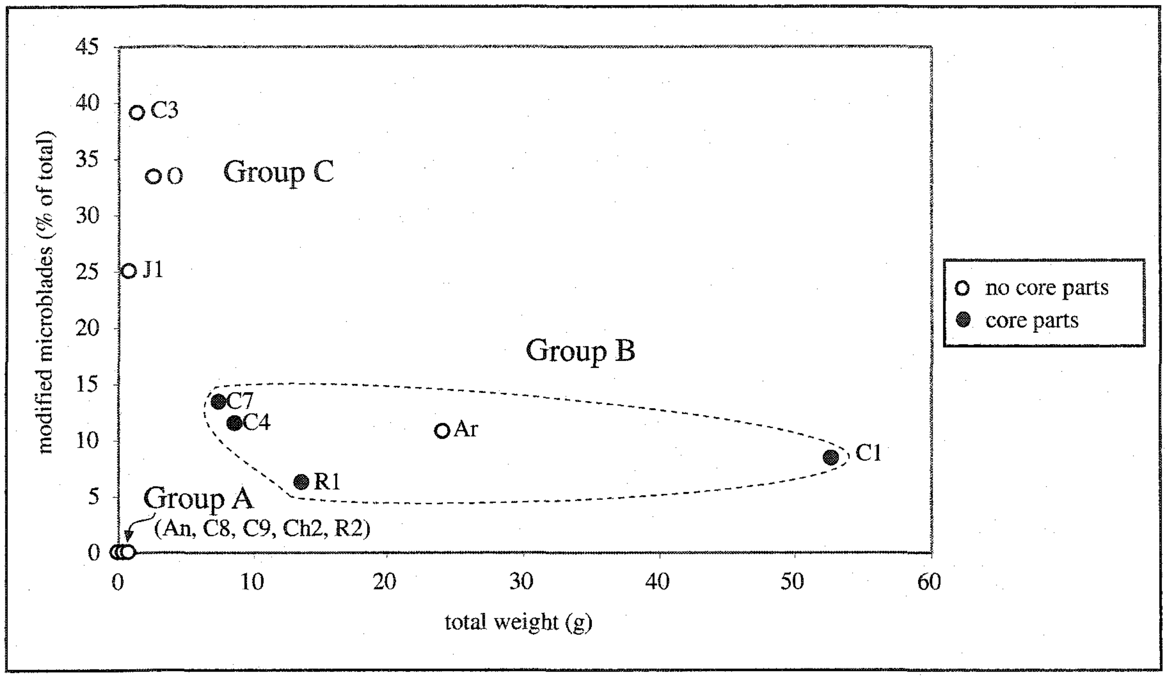

Figure 7.24 Microblade total weight and modification percent by material type.

Metric variables

Summary metric statistics on microblades in Component 3 are provided in Table 7.9, including length, proximal width, proximal thickness, thickness/width (T/W) index, and modified weight by segment, category, modification type, material quality, material type and microblade group (see above for definition of groups). A series of one-way ANOVA tests were conducted to identify any significant differences in the metric variables in microblades among these groups (n>2 independent variables). ANOVA tests the null hypotheses that three or more groups are from the same population against the alternate hypothesis that at least one group is from a different population. Fisher protected least-significant difference (PLSD) tests were used to compare significant differences among category means. Unpaired t-tests were used when there were two independent variables.

In order to assess variability among continuous microblade variables, coefficients of variation ($cv=\sigma 100/\mu$) were calculated for all variable groupings (see Eerkens and Bettinger 2001). Coefficients of variation were generally consistent at 20-40% for proximal width, proximal thickness, and T/W index; length was higher at 40-60%, and modified weight had the largest variability at 67-171%. The lowest length cv was, as expected, for complete specimens (at 35.1%), considerably lower than for broken microblades (47.5-57.8%). Given these data and those presented below, microblade length, width, and thickness were all relatively equivalent concerns to the knappers, as evidenced by their relatively low variability. Interestingly, cv for width and thickness are considerably lower for Group C microblades than for Group A or B (24.5% vs. 28.3, 28.8% for width, 23.1% vs. 30.8, 35.7% for thickness). This suggests that Group C microblades were more uniform with less tolerance for variability in these attributes, and further supports the interpretation that these microblades were brought to the site and discarded from tools. C3 and O, two of the three material types within Group C, had relatively lower cv for width, thickness, and weight. It is important to note that evidence of wear on every specimen may not occur, and that microblades may have been selected for inset based on armature-specific size and shape criteria.

Table 7.10 shows the correlation matrix[8] of microblade length, proximal width, proximal thickness, and modified weight. The highest correlation coefficient is between modified weight and proximal width (r=0.72), with weaker positive correlations of width and thickness (r=0.60) and weight and thickness (r=0.54).

Length

The primary factors influencing microblade length are the height of the core and distal termination. As microblade cores are reduced through platform rejuvenation, core height is reduced. Therefore microblade length (of complete specimens) may be used as a proxy for core height. Hinged terminations, usually the result of imperfections in the material or errors in the application of force, will usually result in reduced microblade length (relative to the core height). In practice, length values are affected most by microblade breakage, and may be unintentional

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[8] Pearson's product-moment correlation coefficients are used.

Table 7.9 Summary metric statistics on Component 3 microblades.

Variable grouping	*N*	*Length*	*Prox. Width*	*Prox. thick.*	*T/W index*	*Mod. Weight*
Segment						
Complete	40	21.1±7.4	5.9±1.8 (1)	1.5±0.4 (2)	26.4±7.0 (2)	0.16±0.21 (3)
Proximal	543	11.1±6.2	6.4±1.5 (2)	1.5±0.4 (2)	24.7±8.3 (1)	0.09±0.13 (3)
Medial	495	10.2±5.9	5.7±1.6 (2)	1.3±0.4 (2)	23.0±6.2 (2)	0.08±0.12 (2)
Distal	268	11.8±5.6	5.1±1.6 (3)	1.3±0.5 (2)	25.5±7.1 (1)	0.07±0.12 (2)
Complete + Proximal	583	11.8±6.8	6.4±1.6	1.5±0.4	25.0±8.0	0.10±0.14
Cross-section						
Triangular	582	10.6±5.8	5.7±1.6	1.4±0.5	24.2±6.7	0.07±0.10
Trapezoidal	762	11.7±6.6	6.1±1.6	1.4±0.4	24.3±7.8	0.09±0.14
Modification						
Unmodified	1216	10.9±6.1	5.8±1.6	1.4±0.5	24.4±7.5	0.08±0.12
Modified	134	13.9±7.0	6.5±1.9	1.5±0.5	23.7±5.8	0.15±0.20
Modification Type						
End modification	31	15.3±6.9	6.9±1.9	1.7±0.5 (2)	26.0±6.9	0.19±0.20
Dorsal damage	3	18.6±8.9	6.7±0.6	2.0±0.7 (2)	28.6±8.8	0.31±0.29
Lateral major damage	34	12.7±6.9	6.1±1.8	1.4±0.4 (2)	23.4±4.8	0.13±0.21
Lateral minor damage	35	14.2±6.8	6.2±2.3	1.3±0.4 (3)	22.2±5.2	0.14±0.20
Lateral retouch	31	13.1±7.0	7.0±1.7	1.6±0.4 (1)	23.0±5.6	0.13±0.15
Modification Type (combinations)						
Lateral major+retouch	65	12.9±6.9	6.5±1.8	1.5±0.4	24.1±6.3	0.13±0.18
Lateral (all)	100	13.3±6.9	6.4±2.0	1.4±0.4	24.0±6.1	0.13±0.19
Material Quality						
High	838	10.9±6.0	5.8±1.6	1.4±0.5	24.3±8.0	0.08±0.12 (1)
Medium	504	11.8±6.6	6.0±1.7	1.4±0.5	24.4±6.2	0.10±0.14 (1)
Low	8	12.4±5.0	5.2±1.8	1.2±0.5	23.5±5.6	0.06±0.04
Material Type						
An	8	12.4±5.0	5.2±1.8	1.2±0.5	23.5±5.6	0.06±0.04
Ar	196	12.7±6.9	6.3±1.7 (6)	1.5±0.4 (4)	24.6±5.7	0.12±0.17 (7)
C1	706	10.5±5.8	5.9±1.6 (3)	1.4±0.5 (1)	24.2±8.3	0.07±0.12 (2)
C3	23	12.1±5.7	5.5±1.0 (2)	1.3±0.3	24.9±5.1	0.06±0.04 (1)
C4	96	12.9±6.9	5.8±1.6 (3)	1.4±0.5 (2)	25.2±6.9	0.09±0.12 (1)
C7	68	13.8±7.3	6.2±1.7 (1)	1.5±0.5 (2)	24.3±7.2	0.11±0.17 (2)
C8	1	15.8	5.1	1.2	22.4	0.03
C9	11	11.7±5.7	5.3±1.5 (2)	1.5±0.5	28.3±6.5	0.07±0.07
Ch2	1	4.7	6.0	1.1	18.1	0.03
J1	4	15.2±10.5	7.5±2.5 (7)	1.5±0.5	20.8±7.3	0.19±0.28
O	39	11.3±6.5	4.9±1.0 (6)	1.2±0.3 (4)	24.3±4.4	0.07±0.07 (1)
R1	192	10.3±5.8	5.8±1.6 (3)	1.3±0.5 (1)	23.6±6.3	0.07±0.12 (2)
R2	2	7.3±1.4	5.9±1.6	1.3±0.2	21.8±1.3	0.03±0.00
Microblade Group						
Group A	23	11.4±5.2	5.3±1.5	1.3±0.4	25.4±6.2	0.06±0.05
Group B	1261	11.2±6.3	5.9±1.7 (1)	1.4±0.5 (1)	24.3±7.5	0.08±0.13
Group C	66	11.8±6.5	5.3±1.3 (1)	1.3±0.3 (1)	24.3±4.9	0.07±0.09
TOTAL	1350	11.2±6.3	5.9±1.6	1.4±0.5	24.3±7.4	0.08±0.13

(#) = number of significant pairwise differences at $p<0.05$ using ANOVA (and Fisher PLSD) for groups with $n>2$ and unpaired t-test for groups with $n=2$.

Table 7.10 Component 3 microblades metric variables correlation matrix.

Variable	*Length*	*Proximal width*	*Proximal thickness*	*Modified weight*
Length	1.00			
Proximal width	0.40	1.00		
Proximal thickness	0.40	0.60	1.00	
Modified weight	0.53	0.72	0.54	1.00

(e.g., result of material imperfections, errors in application of force) or intentional (snapping microblades into usable, uncurved segments).

Only 40 complete microblades were recovered in Component 3, of nine material types, with an average length of 21.1±7.4 mm. ANOVAs were conducted on lengths relative to material type, material quality, modification presence, modification type, cross-section, and microblade group. None showed significant differences in length[9]. Mean length of complete gray chert microblades (n=23) was 19.3±6.2 mm, ranging from 10.3 to 34.0 mm. The gray chert microblade core height was 35.7 mm and the longest microblade flute was 34.41 mm. Mean length of complete black chert microblades (n=6) was 22.7±6.3 mm, ranging from 14.8 to 30.5 mm. The black chert microblade core height was 34.6 mm and the longest microblade flute was 32.3 mm. These data suggest that all microblade cores that produced microblades in Component 3 had relatively similar core heights, producing microblades with similar lengths.

Length measurements were tested to identify significant differences by segment for modified and unmodified microblades (Table 7.11). Modified proximal, medial, and distal segments were significantly different in length compared with unmodified segments, with differences ranging from 2.4 mm (medial) to 6.5 mm (distal). Based on these data, microblades selected for modification were significantly longer than unmodified specimens (except for complete specimens) ($F=9.75$, $df=1343$, $p=0.000$). Microblade lengths among modification types did not differ significantly ($F=0.95$, $df=130$, $p=0.420$).

Lengths by segment (breakage type) and modification were examined to identify any distribution (such as bimodality) that would indicate length preferences for modified microblades. No bimodality was observed. In fact, modified microblades showed a large amount of variation in length (cv = 49.9 vs. 56.6 for unmodified microblades).

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[9] ANOVA results for complete microblade segments ($df=39$): Length by material type, $F=1.57$, $p=0.176$; length by material quality, $F=1.41$, $p=0.257$; length by modification presence, $F=0.04$, $p=0.984$, length by modification type, $F=0.25$, $p=0.705$; length by cross-section, $F=1.23$, $p=0.274$; length by microblade group, $F=0.63$, $p=0.537$.

Table 7.11 Component 3 modified and unmodified microblade length comparisons.

Segment	*N*	*Length*	*T-statistic, df, P value (2-tailed)*
Complete, modified	3	21.2±6.3	-0.20, df=38, p=0.9841
Complete, unmodified	37	21.1±7.6	
Proximal, modified	39	14.9±6.8	-4.07, df=541, p=0.0001
Proximal, unmodified	504	10.8±6.0	
Medial, modified	75	12.2±6.2	-3.23, df=493, p=0.0013
Medial, unmodified	420	9.8±5.8	
Distal, modified	17	18.0±8.4	-4.83, df=267, p=0.0001
Distal, unmodified	252	11.4±5.1	
Total	1347*	11.2±6.3	

* Three specimens could not be measured for length due to fragmentation.

Figure 7.25 includes histograms of microblade length by modification presence and modification type. Unmodified microblades have a normal distribution skewed to the right, whereas modified microblades have a more platykurtic distribution, with higher percentages of larger microblades. Modification types do not show any significant differences in microblade length (see above), and generally do not show clear peakedness around the means. While longer than the average unmodified microblades, microblades picked for utilization varied widely in length. The distributional data suggest that other criteria played a more important role in selection for use.

Width and Thickness

While microblade width measurements have often been viewed as a diagnostic for culture (West 1967; Holmes 1974) and/or microblade core type (Cook 1968; Gallison 1983; Clark 1992), possible confounding variables such as segment type, lithic raw material type, material quality, and modification type should be taken into account (see Wyatt 1970; Workman 1978; Gerlach 1982). Owen (1988:4) notes that curvature of the core face will affect width and thickness. Another important variable in microblade width is recovery technique, and screen mesh sizes greater than 1/8" may result in biased samples (Pearson 1996). Width and thickness measurements are important in that if microblades functioned (at least partially) as insets for composite tools, then thickness and width were constraints based on slot width.

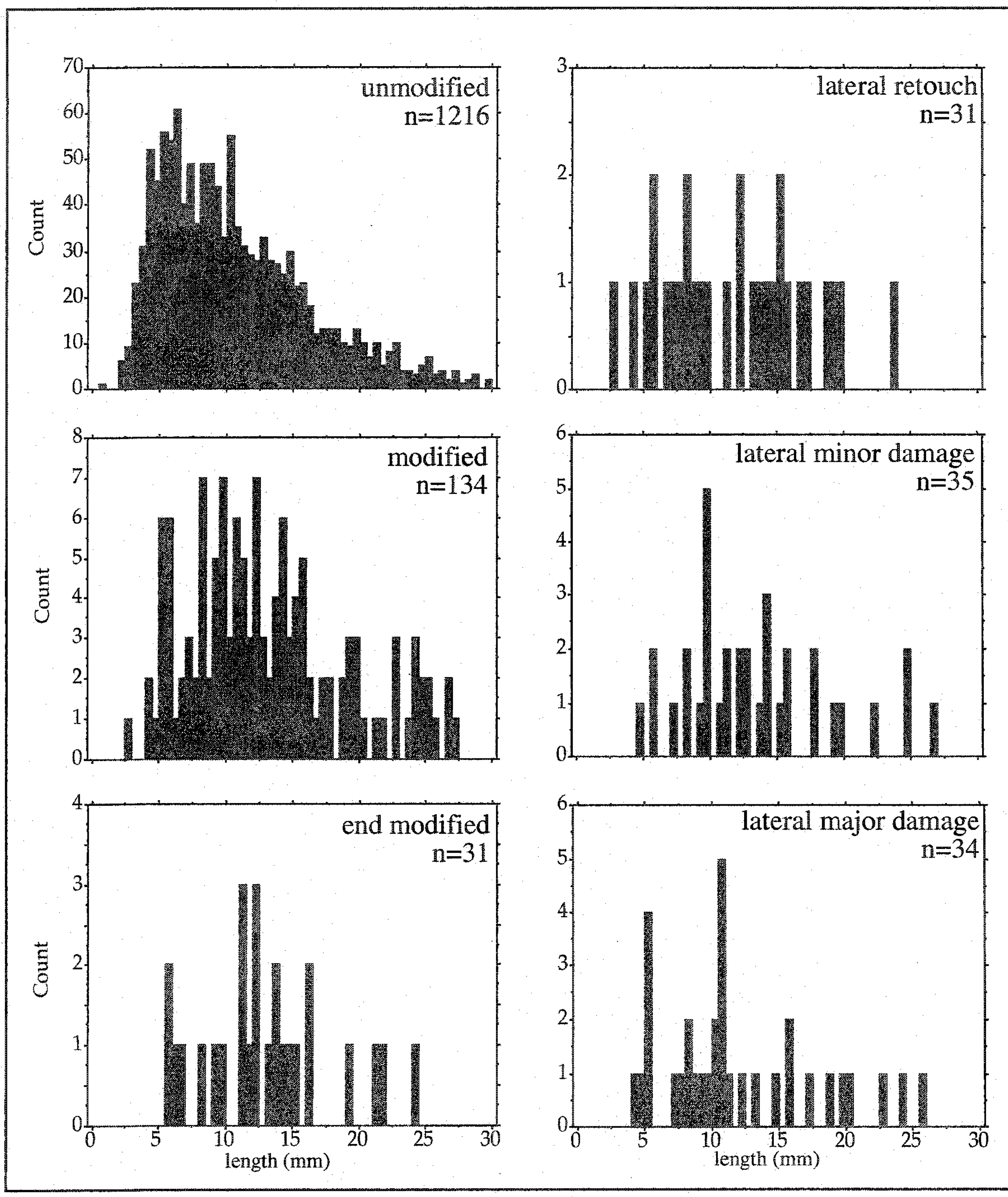

Figure 7.25 Component 3 microblade length histograms.

Relationships of width and thickness in Component 3 are as expected given microblade morphology (Table 7.11). Thickness generally correlates to width ($r = 0.60$, $r^2=0.36$). Complete and proximal segments are generally wider and thicker than medial and distal segments, which is expected considering flake mechanics (Owen 1988). This is important when comparing assemblages. Width and thickness averages and standard deviations should be reported for complete and proximal segments rather than entire microblade population, as a single average may underestimate width and thickness values.

A series of unpaired t-tests and ANOVAs were used to assess differences between unmodified and modified microblades and among modification types in metric variables. Modified microblades are significantly wider than unmodified microblades (average of 6.5 mm vs. 5.8 mm; $t=-85.44$, $df=1356$, $p=0.000$). Modified microblades are thicker than unmodified microblades (average of 1.5 mm vs. 1.4 mm; $t=49.37$, $df=1346$, $p=0.000$). Modified microblades are heavier than unmodified microblades (average of 0.15 g vs. 0.08 g; $t=243.82$, $df=1349$, $p=0.000$).

End modified and laterally retouched microblades are wider and thicker than laterally damaged microblades (7.0 mm and 6.9 mm vs. 6.2 mm respectively). A selection for wider and thicker microblades for end modification and lateral retouch is supported by the data. Metric variables by lithic raw material types are discussed below.

If microblades were selected on the basis of a narrowly defined width criterion, this may be reflected in the distribution of unmodified microblades (e.g., bimodality in width). No bimodality is observed when assessing proximal width regardless of segment (n=1,436), with ranges from 0.7 to 16.3 mm, averaging 5.9±1.6 mm, with a 27.82 coefficient of variance. No bimodality is observed when assessing proximal width of complete and proximal segments (n=583), averaging 6.4±1.6 mm, with a coefficient of variation of 24.67. At the level of the entire Component 3 assemblage, no bimodality was observed, suggesting deletion of microblades with certain preferred widths did not occur. Analysis of widths at various spatial levels is presented in Chapter 10.

To assess the relationships of these variables to proximal width, a series of one-way ANOVA tests were used to identify significant differences ($\alpha=0.05$) and Fisher's PLSD post hoc tests were used for pair-wise comparisons. Significant differences were identified for material type, item, and segment. Material quality and modification type did not yield significant differences in microblade width[10].

Proximal width (n=1,346) is unimodal and approximately normally distributed (mean =5.89 mm, σ=1.64, median=5.77, standard error=0.04, cv=27.8%), symmetric (skewness=0.70), and relatively concentrated around the mean (kurtosis=1.64). Proximal width for complete and proximal segments (n=583) is unimodal and approximately normally distributed (mean =6.36 mm, σ =1.57, median=6.30, standard error=0.06, c.v.=24.67), symmetric (skewness=0.60), and more strongly concentrated around the mean (kurtosis=2.69).

Those categories with significant differences in microblade width measurements are investigated through Fisher's PLSD post hoc tests. Three of the material types were clearly different from the main group. Obsidian microblades tended to be narrower (mean difference between 0.9 and 1.2 mm), and argillite and jasper microblades tended to be wider (mean difference between 0.2 and 1.4 mm for argillite and 1.2-2.5 mm for jasper). The other material types were not significantly different with respect to mean width.

Though material quality was not significant in width distribution, microblades of high quality material tended to be slightly narrower (mean difference=-0.2 mm) than those of medium quality material. Modified microblades were significantly wider than unmodified microblades (mean difference = 0.7 mm) (see above). Complete specimens are wider than distal segments (mean difference = 0.8 mm), proximal segments are wider than medial (0.7 mm) and distal segments (mean difference = 1.3 mm), and medial segments are wider than distal segments (mean difference = 0.6 mm).

Figure 7.26 illustrates microblade width for all specimens and by material type (where n>15). The general pattern for each material type is a normal distribution around a mean of between 5 and 7 mm width. C4, C7, and R1 material types have a bimodal distribution, suggesting deletion of microblades according to a width criterion. These three materials are all within Group B, inferred to be produced on site. The other two materials within Group B (Ar and C1) do not show this bimodality, but the possibility of multiple material types aggregated within C1 could mask patterns. The Group C materials illustrated (C3 and O) do not show a bimodality, but the sample sizes are small (n=23 and 39 respectively). These patterns suggest that within Group B, microblade selection for use was based on widths between 5.0 and 6.0 mm for C4,

[10] ANOVA results: proximal width by material quality, F=268, df=1343, p=0.687; proximal width by

between 5.0 and 7.5 mm for C7, and between 5.5 and 6.5 mm for R1. This inference is supported by the average proximal width for modified microblades for these material types, which fall directly within these ranges (6.4 mm for C4 [n=11], 6.0 mm for C7 [n=9], and 6.4 mm for R1 [n=12]).

Figure 7.27 illustrates microblade width for group and modification. The distributions are all approximately normal for all groups. Group A and C microblades tend to be narrower than Group B microblades. The proximal widths of modified microblades are clearly greater than that of unmodified microblades. Modified microblade widths distribution appears to be more peaked compared with unmodified microblades, suggesting general width selection preferences.

Significant differences in proximal thickness were identified for material type ($F=2.78$, $df=1346$, $p=0.001$). Obsidian microblades were thinner than C1, C4, and C7 (mean difference=0.2, 0.2, 0.3 mm respectively), argillite microblades were thicker than C1, C4, R1, and obsidian (-0.2, -0.1, -0.2, -0.3 mm respectively), and R1 was thicker than C7 (0.1 mm). These differences likely relate to the knapping qualities of the materials. Proximal thickness was significantly different among material quality ($F=3.15$, $df=1346$, $p=0.043$), with low quality materials with lesser thickness values (1.22 mm vs. 1.43 and 1.38 mm for medium and high quality materials respectively). Proximal thickness was also significantly different among modification types ($F=6.18$, $df=130$, $p=0.001$), with end modified microblades thicker than laterally damaged microblades (average of 1.75 mm vs. 1.32-1.41 mm respectively). Laterally retouched microblades had intermediate thickness values (average 1.56 mm).

Microblades were examined for differences in proximal and maximum width and thickness measures. Two issues are addressed, (1) the first relates to the relative frequencies of differences between the two measures (i.e., microblades where the shoulder was not the widest or thickest point), and (2) the second relates to the extent of that difference (measured in mm). Higher relative frequencies could suggest poorer quality material, resulting in microblades that are wider or thicker further from the striking platform. Table 7.12 lists differences in proximal and maximum width and thickness for complete and proximal microblades by material type and group. Fifty-nine microblades (10% of complete and proximal segments) had different proximal and maximum width values. High relative frequencies are noted for Ar, C4, C7, J1, and O. Relative frequencies do not appear to be correlated with sample size ($r = -0.03$). There were no

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modification type, $F=1.31$, $df=133$, $p=0.268$.

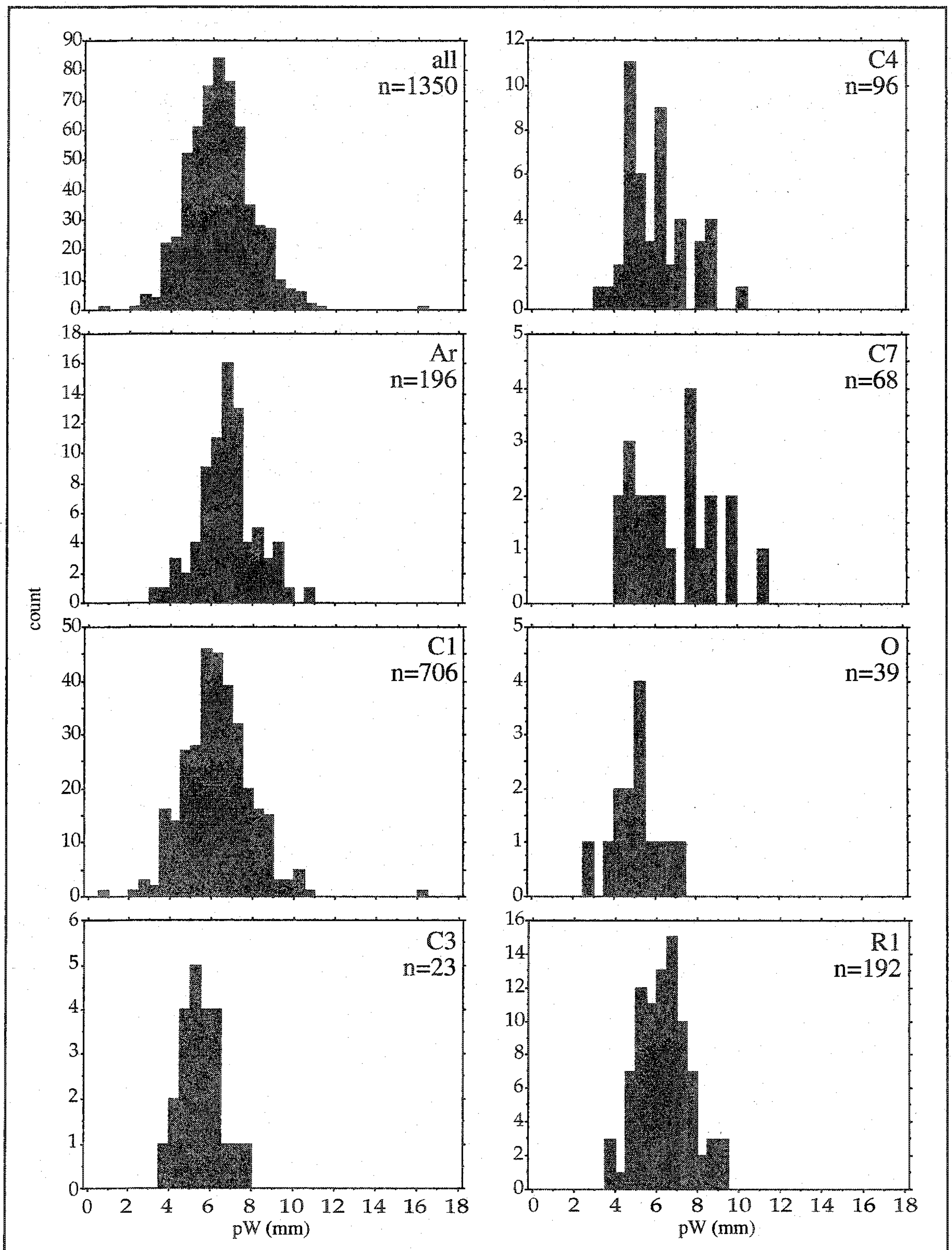


Figure 7.26 Component 3 microblade proximal width by material type.

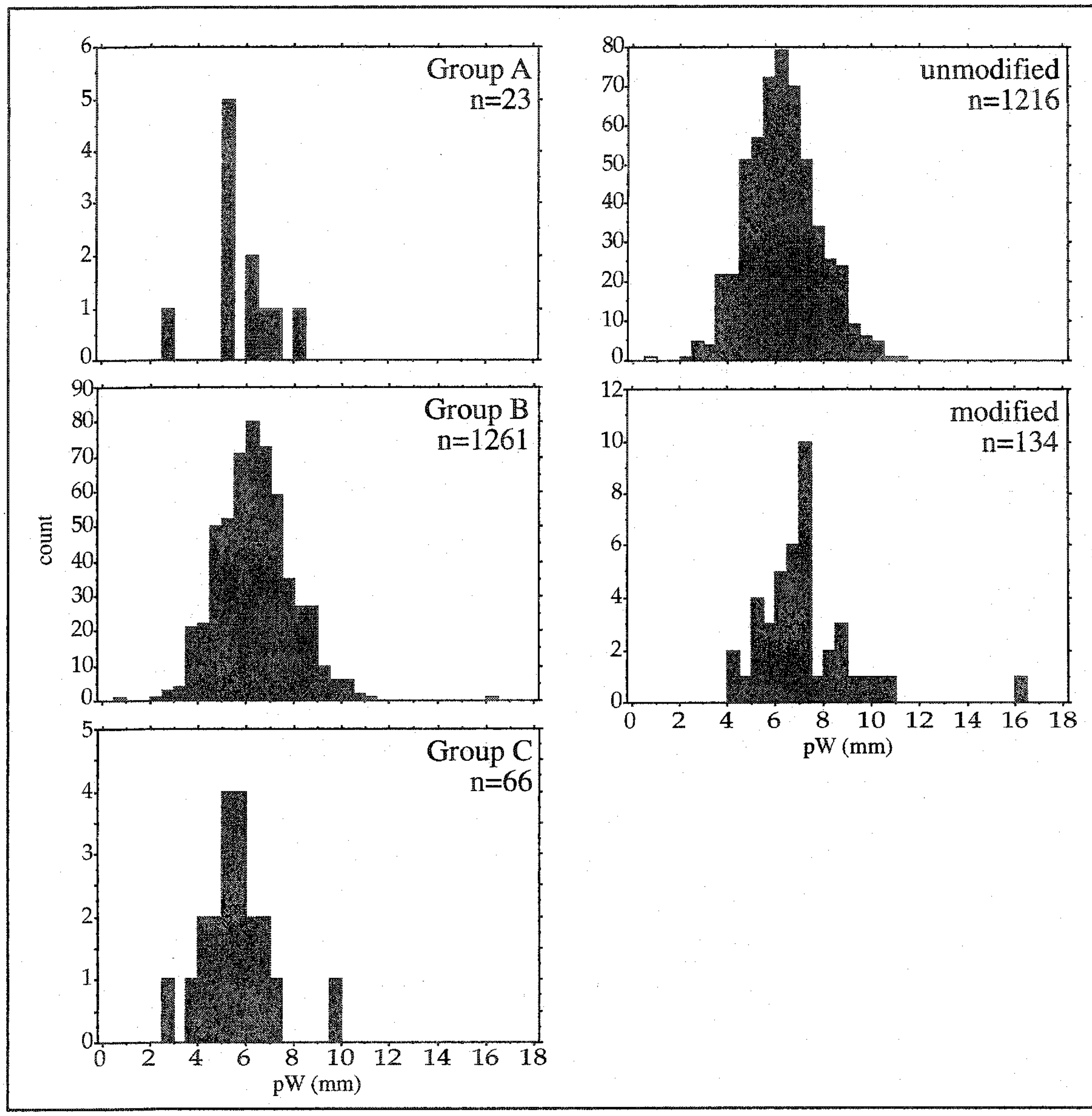


Figure 7.27 Component 3 microblade width by group and modification.

significant differences in maxW-pW among materials (F=0.97, df=582, p=0.475), quality (F=1.00, df=582, p=0.368), or groups (F=0.41, df=582, p=0.662). Not surprisingly, these results suggest that knappers at Gerstle River Component 3 were producing microblades to relatively narrow tolerances with respect to proximal width and thickness, and material type and quality did not make a significant difference in these narrow distributions.

The question of comparability between width measurements taken below the bulb of force (i.e., this study's "proximal width") as advocated by Cook (1968) and Sanger et al. (1970) versus maximum width measurements (this study's "maximum width") as advocated by Owen (1988:17) is examined here. Mean proximal and maximum widths differ only between 0.0 and 0.2 mm per grouping variable, except end modified microblades (with a 0.6 mm difference). Given standard deviations ranging from 1.0 to 2.3 mm (see Table 7.11), this suggests that widths derived from maximum width measurements can be comparable to widths derived from proximal measurements provided a moderate to large sample size (n>100) is available.

Table 7.12 Differences in proximal and maximum width and thickness of complete and proximal microblades by material type, material quality, and microblade group.

Grouping Variable		*maxW – pW*			*maxT - pT*		
	Total N	*N*	*%*	*Mean±1 SD*	*N*	*%*	*Mean±1 SD*
Material							
An	5	0	0.0	0.00	0	0.0	0.00
Ar	78	16	20.5	1.09±0.85	3	3.8	0.19±0.08
C1	318	19	6.0	1.48±1.03	6	1.9	0.41±0.30
C3	4	0	0.0	0.00	0	0.0	0.00
C4	47	8	17.0	1.18±1.08	4	8.5	0.21±0.14
C7	22	6	27.3	0.64±0.27	1	4.5	0.49
C8	1	0	0.0	0.00	0	0.0	0.00
C9	2	0	0.0	0.00	0	0.0	0.00
Ch2	1	0	0.0	0.00	0	0.0	0.00
J1	2	1	50.0	0.16	0	0.0	0.00
O	14	2	14.3	0.63±0.74	2	14.3	0.63±0.22
R1	87	7	8.0	0.55±0.27	0	0.0	0.00
R2	2	0	0.0	0.00	0	0.0	0.00
Quality							
H	359	27	7.5	1.23±0.95	9	2.5	0.47±0.27
M	219	32	14.6	0.97±0.84	7	3.2	0.20±0.11
L	5	0	0.0	0.00	0	0.0	0.00
Group							
A	11	0	0.0	0.00	0	0.0	0.00
B	552	56	10.1	1.12±0.91	14	2.5	0.31±0.23
C	20	3	15.0	0.54±0.55	2	10.0	0.62±0.22
Total	583	59	10.1	1.0±0.9	16	2.7	0.35±0.25

Thickness/width indices are used here instead of thickness alone, because much of the variability in thickness relates to the width (Table 7.11). It is generally thought that thickness positively relates to core face curvature (Clark and Gotthardt 1999:62-63). The ratios in Table 7.9 show very little variability in Component 3 microblades, though there are significant differences microblades classed as facet rejuvenation flakes vs. modified and unmodified microblades (F=13.35, df=1345, p=0.000), the former were relatively thicker than the other microblades (Table 7.9). These data suggest that the material types for which no cores were recovered probably had relatively similar core face widths. Gerstle River Component 3 microblade cores (the two recovered and those not) probably belong to one population and were not significantly different with respect to core width.

Width and width/thickness indices were examined for variation by material type and material quality (Table 7.9). Significant differences were apparent among the material types for width and thickness, suggesting material type constrained widths to an extent. A one-way ANOVA was conducted on material types with >20 specimens, and Fisher PLSD multiple comparison tests were used to identify significant differences. This procedure identified two significantly different populations, obsidian and argillite (F=5.58, df=1318, p=0.000)). Obsidian microblades are narrower than the other groups (between 0.83 and 1.21 mm difference), and argillite microblades are wider (between 0.49 and 1.40 mm difference). Groups A vs. B and A vs. C showed no significant difference in microblade width, but Group B microblades were significantly wider and thicker than Group C microblades (average difference of 0.79 mm) (F=13.86, df=1318, p=0.0002).

In order to examine relationships between microblades, microblade cores, and microblade core by-products (core tablets), complete and proximal microblade widths (n=583) were compared with flute widths from core tablets (n=18) and from microblade cores (n=2) by material type (Table 7.13). Generally, flute width averages were from 1.5-2.0 mm smaller in width than in the microblade sample. The width difference is probably partially related to the fact that flute width measurements for microblade core tablets were made from arris to arris, regardless of the presence of a negative bulb, given the fragmentary nature of the tablets. When flutes with negative bulbs present are averaged, they yield averages more within the range of the microblade sample. The two microblade core examples may have been exhausted, so this factor could be partially responsible for the observed differences. However, a larger sample size of microblade cores is needed to further test this relationship. The greater proximal average width of microblades suggests that the microblade cores were curated or at least not exhausted in Component 3, and were taken from the site.

Table 7.13 Component 3 microblade widths and microblade core and core tablet flute widths.

Material	*N MB*	*pW*	*N MBCT (n flutes)*	*Flute width*	*N MBC (n flutes)*	*Flute width (flutes with negative bulbs)*
C1	318	5.9±1.6	12 (38)	3.8±1.3	1 (8)	4.4±1.8 (6.2±2.8)
C4	47	5.8±1.6	1 (5)	2.4±1.0	1 (12)	3.7±1.3 (4.4±0.8)
C7	22	6.2±1.7	3 (5)	3.8±0.7	-	-
R1	87	5.8±1.6	2 (4)	3.3±0.1	-	-
TOTAL	583	5.9±1.7	18 (52)	3.6±1.3	2 (20)	3.9±1.5 (4.8±1.5)

Segment Representation

Segment representation and inferred segment deletion can be informative with respect to microblade use; however, relative frequencies of segments can relate to other factors. A single microblade can have only one striking platform remnant and proximal end; however, multiple medial sections can represent one microblade, and thus be over-represented.

Microblade segment types include 40 (3.0% of total microblades) complete, 543 (40.2%) proximal segments, 497 (36.8%) medial segments, 268 (19.9%) distal segments, and 2 (0.1%) unidentifiable to segment (Table 7.14). The relative low frequencies of distal fragments could relate to the fact that some microblades hinge or break off distally or the smaller size of these specimens. Based on the material excavated, at least 541 microblades were detached from cores at Gerstle River Component 3 (∑ complete and proximal unmodified segments). Microblade fragmentation index (mbFI) is derived by dividing total microblades by complete unmodified microblades. The Component 3 mbFI is quite high, 36.5, especially when compared with Component 2 microblades (mbFI = 7.4). This index may be a useful comparative statistic to examine microblade assemblage variability and taphonomy.

Given the large block excavation undertaken at Gerstle River, some inferences about deletion of certain microblade groups from the assemblage can be made. All other things being equal, assuming that a sufficient representative sample at the site was recovered, and no medial segments were selectively deleted from the assemblage, medial microblade segments should yield an equal or greater sum than proximal microblade segments (see Powers 1983:107-111). However, a conservative estimate of one medial microblade segment per proximal microblade segment suggests that at least 119 specimens were removed from the site, perhaps as tool insets within composite tools. Powers (1983:111) note that microblades could be snapped into four or more medial segments per complete microblade, which could make this estimate much higher. However, given the average length of complete microblades of 21.1 mm and length of retouched medial segments of 12.2 mm, and ignoring curvature and other exigencies, an estimate of one or two usable medial segments per complete microblade seems to be supported at Gerstle River Component 3. Estimating the percentage of microblades detached from cores on site that were selected for use in composite tools is difficult, but not intractable. However, such an estimate necessitates detailed spatial analyses, which are presented in Chapter 10.

Table 7.14 Component 3 microblade frequencies of segment by modification.

Segment	*MB*		*MMB*		*Total*	
	N	*%*	*N*	*%*	*N*	*%*
Complete	37	3.0	3	2.2	40	3.0
Proximal	504	41.5	39	29.1	543	40.3
Medial	423	34.8	75	56.0	497	36.9
Distal	251	20.7	17	12.7	268	19.9
TOTAL	1214*	100.0	134	100.0	1348	100.0

*Two specimens could not be identified to segment.

A test of whether microblades were broken randomly is to compare segmentation by material types and microblade groups. A chi-square test shows significant differences in segment frequencies by material type (χ^2=69.4, df=36, p=0.001). After excluding material types with <10 specimens (n=5), a total of eight material types were examined, including only two medium quality material types, gray rhyolite and argillite. Both of these have similar distributions of segments (~40% proximal, ~40% medial, ~20% distal). The remaining material types (n=6) have varying segment distributions. Much of the variation is due to microblade group (defined by percentages of modified microblades) (Table 7.15, Figure 7.28). Group B and C are clearly different in relative frequencies of medial segments (31-39% vs. 54-70% respectively). While there is only one material type in Group A with >10 specimens, it is clearly different in having smaller frequencies of proximal and larger frequencies of distal segments than any other group. These frequencies suggest that microblade segmentation is not random or largely accidental, but is related to behavioral strategies for transforming microblades into usable tools. The differences

Table 7.15 Component 3 microblade segmentation relative frequencies by material type and microblade group.

Group	Material type	N*	Complete %	Proximal %	Medial %	Distal %
A	C9	11	9	9	36	45
B	Average	1259	3	39	36	22
	Ar	196	0	40	39	21
	C1	706	3	42	35	20
	C4	95	6	43	31	20
	C7	68	4	28	38	29
	R1	194	1	44	37	19
C	Average	62	6	21	62	12
	C3	23	4	13	70	13
	O	39	8	28	54	10
TOTAL		1348	4	31	42	22

*Two specimens could not be identified to segment.

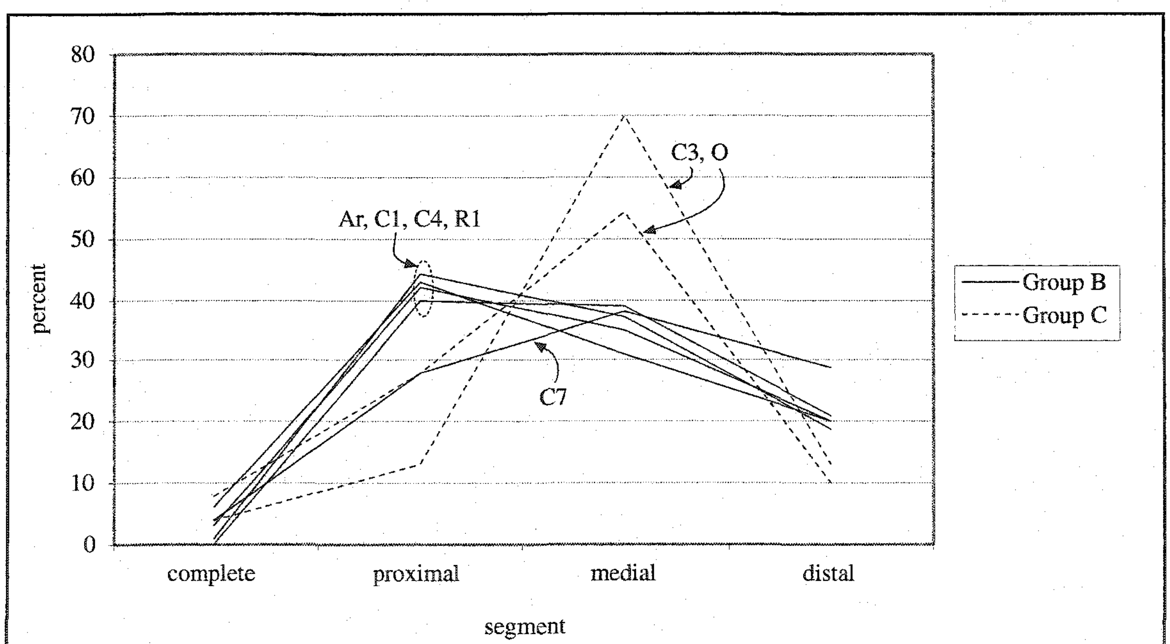


Figure 7.28 Component 3 microblade segmentation by material type and groups (B and C).

between Group B and Group C material types give further support for the hypothesis that Group B microblades were selected for further modification and use, reflected in the lower medial frequencies, and Group C microblades were discarded on-site, after their production elsewhere. Group A microblades were likely produced on-site, as evidenced by the higher distal segment relative frequencies and lack of modified microblades, but the sample size is small (one material type with 11 specimens).

Arrises and Cross-section

Frequencies of arrises (dorsal ridges) may relate to stage of reduction, especially as they relate to microblade width. Arrises may be negatively correlated with narrowness of the core, or width of the fluting arc. Two dorsal arrises could reflect a narrower lateral edge angle, and one could reflect a wider lateral edge angle. Arrises were measured at a point 10 mm from the proximal end and represents the number of dorsal ridges that most characterizes each specimen. An alternate method, not used here, distinguishes intermediate forms with 1-2 or 2-3 arrises (Clark and Gotthardt 1999:60). Microblade cross-section is defined here as triangular for microblades with one arris, and trapezoidal for microblades with 2 or more arrises. The importance of cross-section in microblade selection as lateral insets into composite tools has been variously ascribed in the archaeological literature. Guthrie (1983b:357-359) suggests that triangular microblades were produced as insets whereas trapezoidal microblades were waste products of core preparation, whereas other researchers hold that the opposite was true (Gallison 1983; Flenniken 1987). In practice, the platform location differs with respect to cross section; platforms located on arrises generally result in triangular cross-sections, and platforms located between arrises generally result in trapezoidal cross-sections. Microblades with trapezoidal cross sections generally have more acute edge angles and are wider and more brittle.

Statistical summaries of arrises for each grouping variable are presented in Table 7.16. Component 3 included 583 microblades with one arris (43% of total), 649 with two arrises (48%), 110 with three arrises (8%), and 4 with four arrises (<0.1%). The average number of arrises for Component 3 microblades is 1.65 ± 0.64 for all microblades. There is no significant difference in number of arrises between modified and unmodified microblades ($t=0.36$, $p=0.718$). There are some differences among material types, with C4 having more multi-arris microblades and R1 having slightly more single-arris microblades ($F=2.53$, $df=1346$, $p=0.003$). There is no significant differences in number of arrises by material quality ($F=0.53$, $df=1346$, $p=0.569$) or microblade group ($F=1.62$, $df=1346$, $p=0.198$).

Table 7.16 Component 3 microblade arris summary data.

Variable grouping	N	N Arrises	Triangular cross-section N	Triangular cross-section %	Trapezoidal cross-section N	Trapezoidal cross-section %
Category						
MB	1213	1.66±0.64 (1)	524	43.2	689	56.8
MMB	133	1.63±0.66 (1)	59	44.4	74	55.6
Modification Type						
Unmodified	1213	1.66±0.64	524	43.2	689	56.8
End modification	30	1.58±0.76	15	50.0	15	50.0
Dorsal damage	3	1.67±0.58	1	33.3	2	66.7
Lateral major damage	34	1.62±0.65	16	47.1	18	52.9
Lateral minor damage	35	1.71±0.71	15	42.9	20	57.1
Lateral retouch	31	1.61±0.50	12	38.7	19	61.3
Material						
An	8	1.50±0.53	4	50.0	4	50.0
Ar	196	1.74±0.66 (2)	74	37.8	122	62.2
C1	703	1.63±0.63 (2)	312	44.4	391	55.6
C3	23	1.52±0.67 (1)	13	56.5	10	43.5
C4	96	1.85±0.68 (4)	30	31.3	66	68.8
C7	68	1.72±0.69 (1)	27	39.7	41	60.3
C8	1	1.00	1	100.0	0	0.0
C9	11	1.36±0.50 (2)	7	63.6	4	36.4
Ch2	1	2.00	0	0.0	1	100.0
J1	4	2.00±0.82	1	25.0	3	75.0
O	39	1.79±0.70 (2)	14	35.9	25	64.1
R1	194	1.53±0.58 (4)	99	51.0	95	49.0
R2	2	1.50±0.71	1	50.0	1	50.0
Material Quality						
H	834	1.64±0.64	366	43.9	468	56.1
M	504	1.67±0.64	213	42.3	291	57.7
L	8	1.50±0.53	4	50.0	4	50.0
Group						
A	23	1.43±0.51	13	56.5	10	43.5
B	1257	1.65±0.64	542	43.1	715	56.9
C	66	1.71±0.70	28	42.4	38	57.6
TOTAL	1346*	1.65±0.64	583	43.3	763	56.7

* number of arrises could not be determined on 4 microblades
(#) = number of significant pairwise differences at $p<0.05$ using ANOVA (and Fisher PLSD) for groups with $n>2$ and unpaired t-test for groups with $n=2$.

A one-way ANOVA test was also used to test for differences in width for each arris class. Proximal widths are significantly greater on microblades with more than one arris ($F=40.01$, $df=3$, $p=0.000$). Generally, the wider the microblade, the more arrises are present: 5.7±1.6 mm for one arris microblades (n=581), 6.0±1.6 mm for two arris microblades (n=648), 6.4±1.6 mm for three arris microblades (n=110), and 7.9±1.7 mm for four arris microblades (n=4). Based on these data, number of arrises of Gerstle River Component 3 microblades are largely dependent on microblade width, and not on any selection criteria. The presence of a thin cutting edge (in the case of laterally modified microblades) and thickness (in the case of end retouched microblades) were more important criteria in microblade selection for use.

There is no significant difference in thickness (t=-0.52, p=0.600) or T/W index (t=-0.18, p=0.855) between microblades with triangular (n=581) and trapezoidal (n=761) cross-sections, though trapezoidal microblades are wider (6.05±1.63 mm vs. 5.67±1.62 mm, t=-4.22, p=0.000). Cross-section did not appear to play an important role in differentiating modified and unmodified microblades (t=0.26, p=0.798). These data suggest that other qualities, such as thickness and width, were more important in selection of microblades for further modification.

Raw Material

Component 3 microblades were made from 13 different material types, with 62.1% made on high quality materials (cherts and obsidian), 37.3% made on medium quality materials (argillite and rhyolites), and 0.6% made on low quality materials (andesite). Microblades per material type ranged from one (C8, Ch2) to 707 (C6), averaging 104 per material type. Gray chert (52.4%), argillite (14.5%), gray rhyolite (14.4%), and black chert (7.1%) dominate with 88.4% of microblades.

A comparison of microblades to microblade cores and core parts by raw material type illustrates the scarcity of core fragments in the assemblage relative to other Components (Table 7.17), yielding a ratio of 675 microblades/core. For comparison, Dry Creek Component 2 contained 1,772 microblades in 8 material types and 21 microblade cores, for a ratio of 84 (Powers 1983:107). Healy Lake (Chindadn) contained 92 microblades and 2 described microblade cores, for a ratio of 46 (Cook 1996). Microblade/core ratios from other subarctic interior assemblages range from 8 at Otter Falls (Workman 1978) to 200 at Broken Mammoth CZ2 (Yesner and Pearson 2002), averaging 118±196 with Gerstle River Component 3 ratio included, and 63±70 with the ratio excluded. Of the nearly 300 assemblages in interior Alaska with microblade technology, almost 70% of them did not contain microblade cores (and nearly 5% contained micoblade cores with no microblades). The wide variability in this ratio suggests that factors that affect microblade use and role in technological organization at various sites may be complicated.

Of the 13 material types, only four have microblade cores and/or core parts, C1, C4, C7, and R1. While some of the sample sizes are small, the absence of core fragments of Ar is interesting given the inference of microblade production for this material in Area A.

Despite the generally low cv values for width and thickness for microblades regardless of material type, suggesting relatively high standardization of microblade production, three of the material types show significant differences (see above, Figure 7.26). Obsidian microblades tend to be smaller (i.e., narrower and thinner) and argillite and jasper microblades tend to be larger. Given the small sample size of jasper, generalizations are unwarranted; however obsidian and argillite microblades do represent different populations with respect to size and may have been detached from microblade cores with different platform characteristics. Given that obsidian is an exotic material type, and relatively more microblades are damaged, the differences in metric attributes may be partially related to use and discard.

Table 7.17 Component 3 raw material frequencies for microblades, microblade cores, and core parts.

Material Type	*Microblades*		*Modified microblades*		*FRF*		*Microblade core tablets*		*Microblade cores*		*Microblade core fragments*	
	N	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*
An	8	0.7	-	-	-	-	-	-	-	-	-	-
Ar	175	14.5	21	15.7	-	-	-	-	-	-	-	-
C1	645	53.3	58	43.3	5	56.0	12	66.7	1	50.0	2	66.7
C3	14	1.2	9	6.7	-	-	-	-	-	-	-	-
C4	85	7.0	11	8.2	2	22.0	1	6.0	1	50.0	1	33.3
C7	57	4.7	9	6.7	2	22.0	3	17.0	-	-	-	-
C8	1	0.1	-	-	-	-	-	-	-	-	-	-
C9	11	0.9	-	-	-	-	-	-	-	-	-	-
Ch2	1	0.1	-	-	-	-	-	-	-	-	-	-
J1	3	0.3	1	0.8	-	-	-	-	-	-	-	-
O	26	2.2	13	9.7	-	-	-	-	-	-	-	-
R1	182	15.0	12	9.0	-	-	2	11.0	-	-	-	-
R2	2	0.2	-	-	-	-	-	-	-	-	-	-
Total	1210	100	134	100	9	100	18	100	2	100	3	100

Distal Termination

The form of the microblade termination is related to shape of the fluted face, raw material, and direction and intensity of applied force, however few controlled studies have been conducted (see Owen 1988:3-7). The majority of Gerstle River Component 3 microblades are broken or snapped at their distal end (n=1038, 77.0% of total). At present, there is no way to distinguish intentionally snapped, accidentally broken, or pieces broken during detachment from the core (see Powers 1983:110). There are 308 complete and distal fragments which retain the original termination, hinge and overshoot terminations are rare (n=20, 6.4% and n=7, 2.3% respectively). Most terminations are feathered (n=224, 72.7%), and a number of others classed as snap/break terminations (n=39, 12.7%) were also likely feathered, but they are snapped within ~4 mm of the distal terminus. In some cases, proximal specimens with snapped or broken distal ends may be complete specimens that snapped during detachment. Given the presence of numerous hinge fractures on the UA2003-54-1408 microblade core and hinge fractures on the dorsal surfaces of a number of microblades, it is likely that premature breakage was a problem in microblade production in Component 3 (see Powers 1983:110; Cook 1969).

Other Qualitative Attributes

While platform attributes were not examined specifically, other than presence/absence and presence of platform preparation, the platforms on Component 3 microblades were generally characterized by smooth, single facets. Multifaceted, battered, or ground platforms were rare. Platform preparation was very common (n=544, 93.3% of total complete and proximal segments) generally consisted of crushing, battering, and/or microflaking, perhaps aiding in the positioning of pressure tools to detach microblades (see Owen 1988:4). In rare cases, this preparation and resulting microblade detachment blow removed or obliterated the striking platform (n=28, 1.9%). The zone of battering generally extended from the platform to ~5 mm down the dorsal face. Multiple tiny hinge and step fractures were common in this area. Ventral attributes like presence of lipping on the ventral platform edge and errailures on the bulb of force were not systematically recorded; however, lipping and errailures were uncommon, and are estimated to occur in less than 10% of the sample.

These results are consistent with other interior early Holocene assemblages, with lipping rare (2-14%) and eraillures uncommon (22%) (Owen 1988:291). Bulbs of force ranged from salient to diffuse, with most microblades considered moderately diffuse, but with no obvious variability in material types. This suggests that similar percussor types were used on all cores, regardless of material type. This further supports the hypothesis that the microblade production/core maintenance occurring in Gerstle River Component 3 was in approximately the same (late) stage of reduction and use.

Microblade modification

A total of 134 microblades exhibited some type of secondary modification (9.9% of all Component 3 microblades) (Figures 7.29-7.32). Modification on microblades could derive from natural processes such as trampling, or through human modification. Given generally pristine flake edges (on 98.8% of flakes and 90.1% of the microblades), deposition in an aeolian silt environment with little evidence of post-occupation disturbance, and the nature of the modified microblades, it is argued here that microblades showing edge damage were used or intentionally retouched.

Modification types consist of end modification (usually distal), dorsal damage, lateral major damage, lateral minor damage, and lateral retouch. The last three categories are combined in a lateral modification category. End modified microblades (n=31, 23.1% of modified microblades) are defined as usewear or retouch on the distal or proximal edge, and generally appeared as distal-dorsal microflaking (Figure 7.29). Only a few microblades with dorsal damage (n=3, 2.2%) were identified, on the basis of grinding or crushing damage on one or more dorsal arrises (Figure 7.32). Of all modification types, this damage may have occurred while the microblade was part of the parent core. Microblades with major lateral damage on one or more edges (n=35, 26.1%) are defined by the presence of chips or gouges removed from the lateral edge(s) (Figure 7.31). While intentional microflaking retouch was not observed on this type, this type of damage would be consistent with usewear. Microblades with minor lateral damage on one or more edges (n=34, 25.4%) exhibit less distinctive damage, often in the form of small chips removed from the lateral edge(s) (Figure 7.32). This class was used for those microblades whose damage may not have resulted from use, and could reflect natural damage produced during production or later disturbance (trampling, etc.). However, given the high percentage of microblades with no lateral damage (n=1,210, 90.1% of total Component 3 microblades), it is likely that these microblades were also used. Microblades with lateral retouch (n=31, 23.1% of modified microblades and 2.3% of total Component 3 microblades) are defined on the basis of unifacial flaking (generally on one or more lateral-dorsal edges) (Figure 7.30).

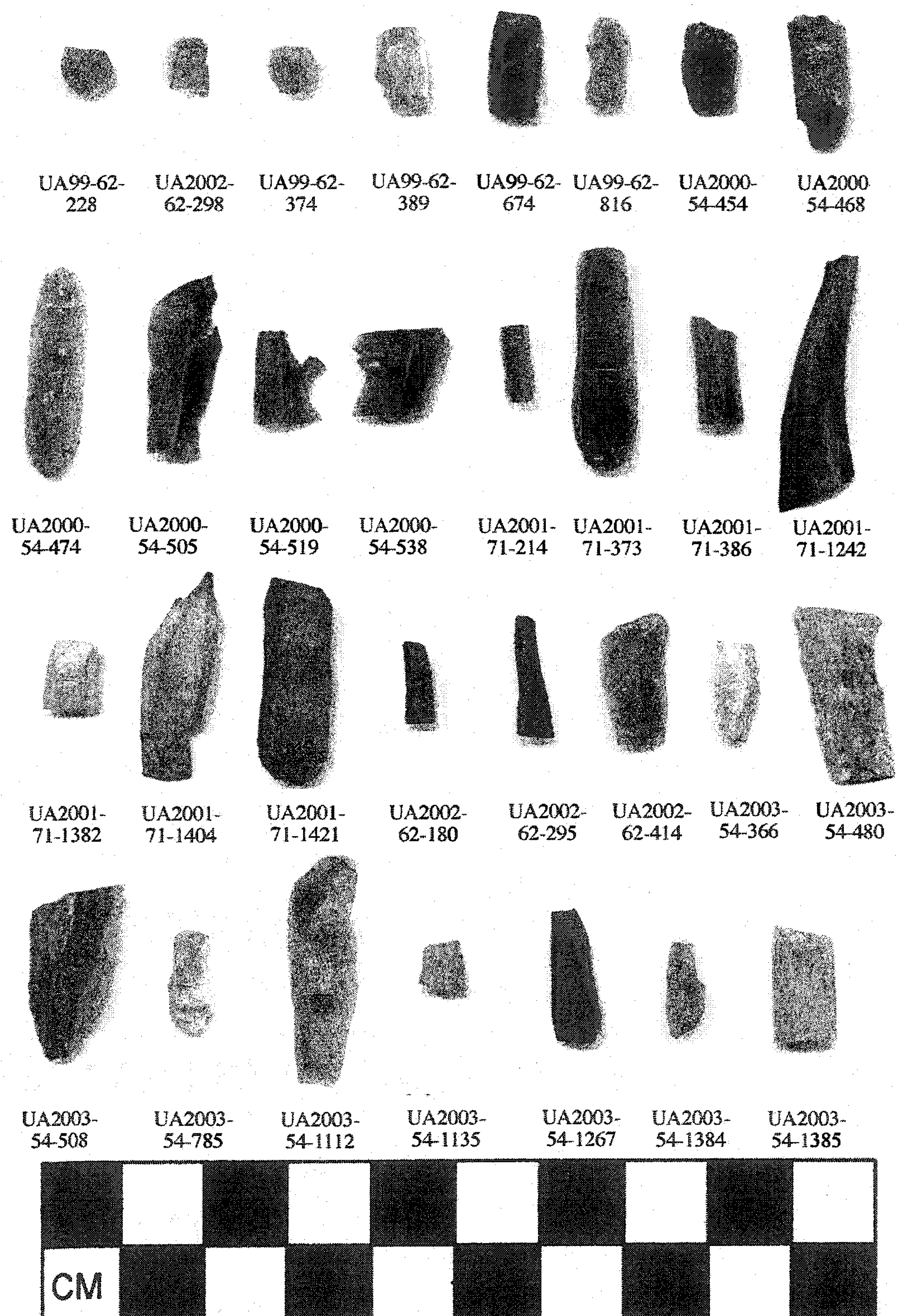


Figure 7.29 Component 3 modified microblades (end modification).

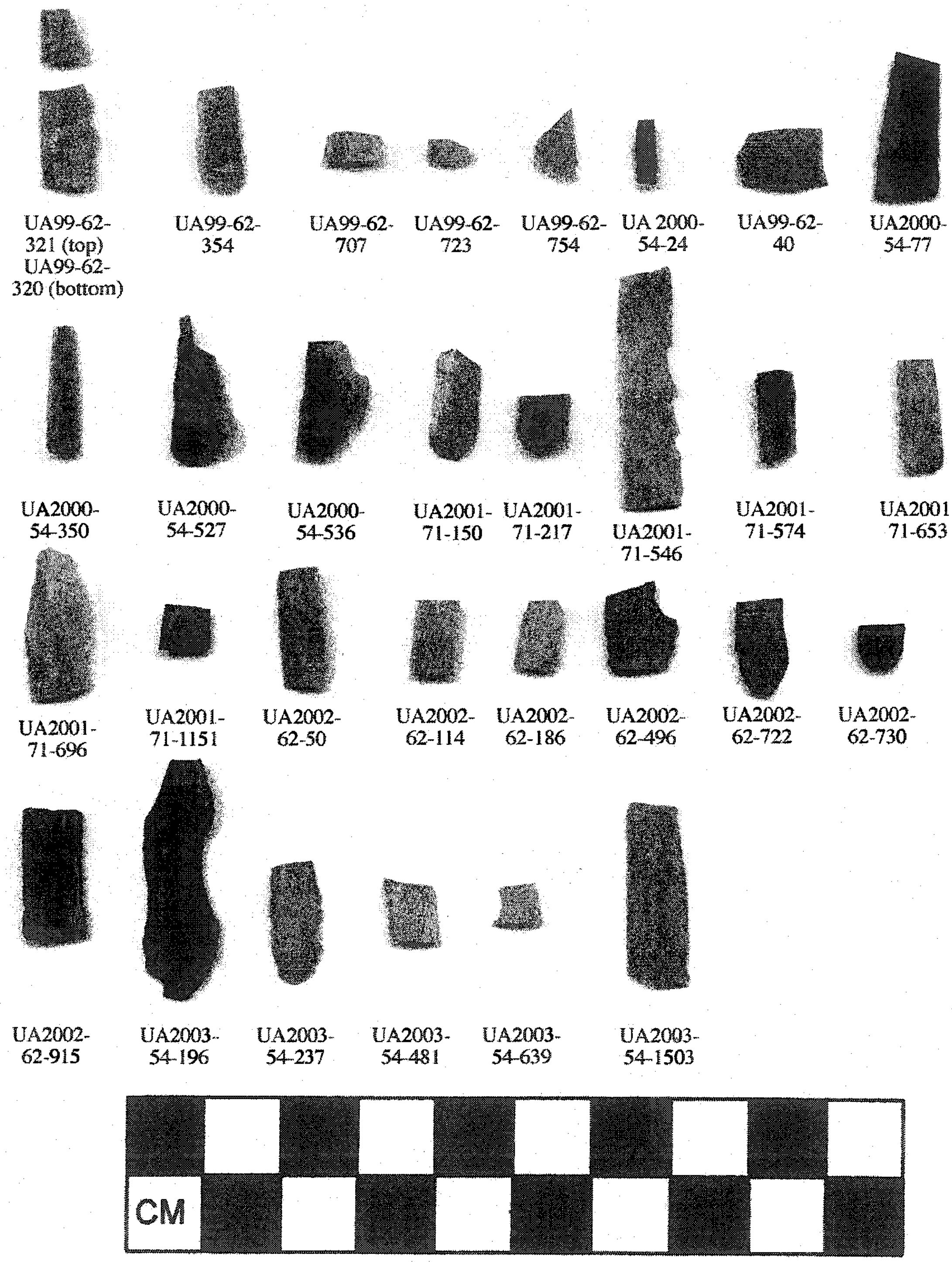


Figure 7.30 Component 3 modified microblades (lateral retouch).

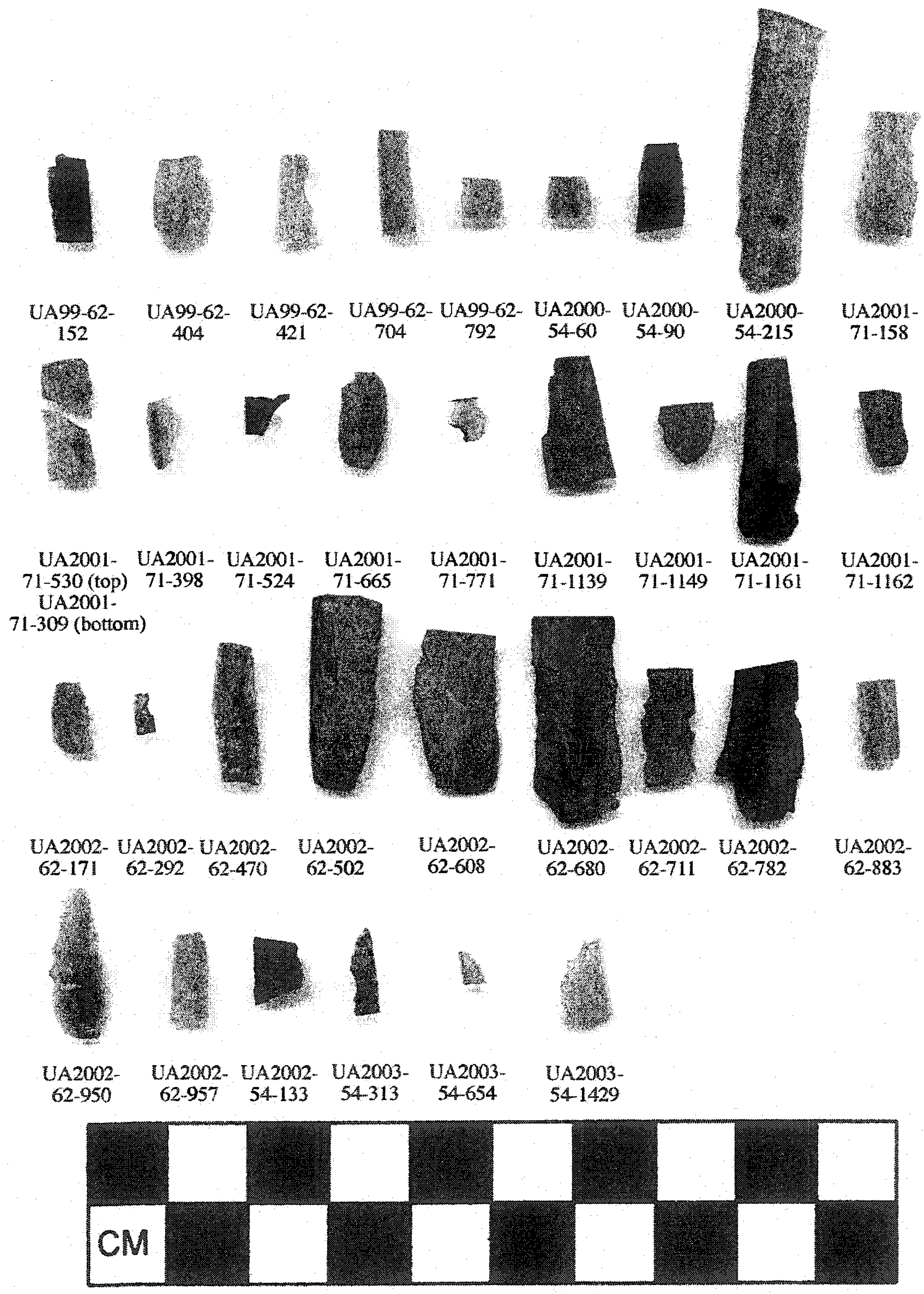


Figure 7.31 Component 3 modified microblades (major lateral damage).

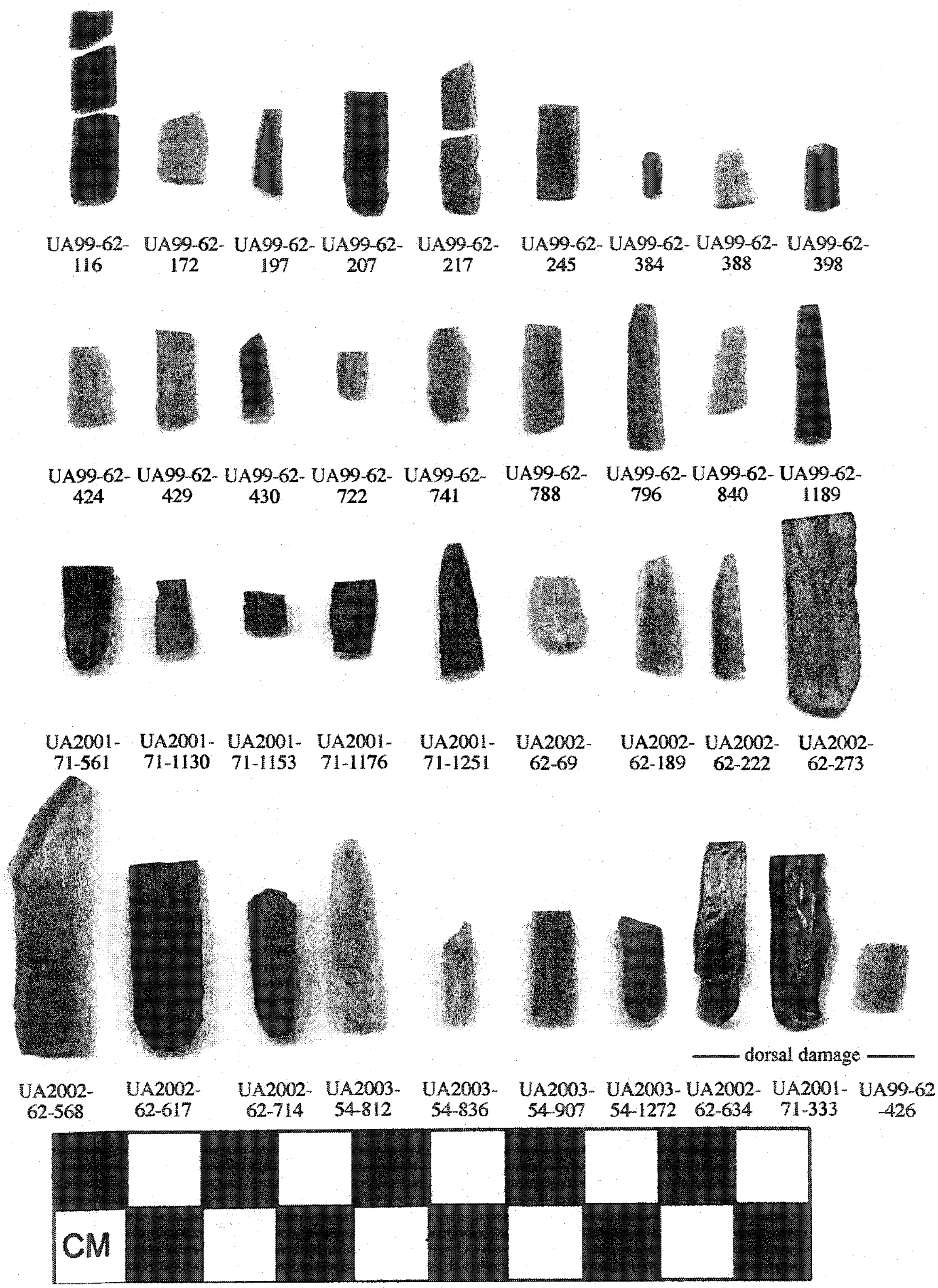


Figure 7.32 Component 3 modified microblades (minor lateral damage, dorsal damage).

Modified and unmodified microblades were tested for differences in metric and discrete variables (see Tables 7.16 through 7.19). Modified microblades are on average significantly longer (13.9 vs. 10.9 mm), wider (6.5 vs. 5.8 mm), thicker (1.5 vs. 1.4 mm), and heavier (0.15 vs. 0.08 g) than unmodified microblades[11]. Modified microblades are represented by relatively greater frequencies of medial and lesser frequencies of distal and proximal segments[12].

Coefficient of variation values suggest that modified microblades are more standardized with respect to length, width, thickness, T/W index, and modified weight (Table 7.18). The lowest variability in length and modified weight is for end modified microblades, suggesting that these attributes were important in selecting the microblade blank. Laterally retouched microblades show the lowest variability in proximal width and thickness, suggesting that these attributes were important for this class. Microblades with lateral major damage share similar cv values with laterally retouched microblades, suggesting that both are from similar functional categories. Microblades with minor lateral damage are generally more variable, especially with respect to width and thickness, suggesting that some of these specimens may have secondary damage from natural causes.

Table 7.18 Coefficients of variation for metric variables of Component 3 microblades by modification type.

Variable	*Un-modified*	*Modified*	*End mod.*	*Lateral (all)*	*Lateral major*	*Lateral minor*	*Lateral retouch*
Length	56.0	50.4	45.1	51.4	54.3	47.9	53.4
Proximal width	27.6	29.2	27.5	31.0	29.5	37.1	24.3
Proximal thickness	35.7	33.3	29.4	28.6	28.6	30.8	25.0
L/W index	52.1	40.2	37.8	41.2	40.7	35.9	38.5
T/W index	30.7	24.5	26.5	25.4	20.5	23.4	24.3
Modified weight	150.0	133.3	105.3	140.5	161.5	142.9	115.4

To further explore metric variable differences by modification and modification types, a series of ANOVAs were conducted on all continuous variables by modification type (unmodified, end modification, lateral major damage, lateral minor damage, and lateral retouch). Given similarities discussed above, lateral major damage and lateral retouch were collapsed for series 2. All lateral modification categories were collapsed for series 3. Modified microblades were

[11] t-test results (df = 1346): length by modification presence, t=-53.74, p=0.000; proximal width by modification presence, t=-85.44, p=0.000; proximal thickness by modification presence, t=49.37, p=0.000; modified weight by modification presence, t=243.82, p=0.000.

[12] χ^2 test result: segmentation by modification presence, χ^2=23.56, df=3, p=0.000.

subdivided by modification location and type in series 4. Dorsally modified microblades were also excluded from series 4 given the small sample size (n=3) and the ambiguity regarding modification while part of the parent core or after detachment. Results are presented in Table 7.19.

Table 7.19 ANOVA results for microblade modification types.

Variable	*Series 1 (df=1343)*	*Series 2 (df=1343)*	*Series 3 (df=1343)*	*Series 4 (df=130)*
L	F=7.34, p=0.000	F=9.76, p=0.000	F=14.16, p=0.000	F=0.95, p=0.420 ns
PW	F=7.19, p=0.000	F=8.08, p=0.000	F=11.64, p=0.000	F=1.71, p=0.167 ns
PT	F=6.2, p=0.000	F=7.67, p=0.000	F=10.00, p=0.000	F=6.18, p=0.001
T/W	F=0.54, p=0.708 ns	F=0.46, p=0.711 ns	F=0.68, p=0.509 ns	F=0.73, p=0.533 ns
N arrises	F=0.24, p=0.916 ns	F=0.32, p=0.812 ns	F=0.21, p=0.813 ns	F=0.25, p=0.858 ns
Modified wt.	F=11.19, p=0.000	F=14.94, p=0.000	F=22.42, p=0.000	F=0.72, p=0.545 ns

ns=not significant

In all series, significant differences in these categories were identified in length, width, thickness, and modified weight, but none in T/W index and number of arrises between these categories. The combination of lateral modification categories in series 2 and 3 increased the significance of the differences. For series 3, laterally modified microblades average 2.4 mm longer, 0.6 mm wider, 0.06 g heavier than unmodified microblades. End modified microblades average 4.4 mm longer, 1.1 mm wider, 0.4 mm thicker, and 0.1 g heavier than unmodified microblades. End modified microblades also average 0.3 mm thicker and 0.1 g heavier than laterally modified microblades. In general, larger, wider, and thicker microblades seem to be preferred for selection as tool blanks for further modification.

For series 4, of the continuous variables, only proximal thickness shows significant differences. Laterally retouched microblades were thicker than lateral minor damaged microblades (mean difference of 0.2 mm), and end modified microblades were thicker than lateral major and minor damaged microblades (mean differences of 0.3 and 0.4 mm respectively). When laterally modified categories are collapsed and compared directly with end modified microblades, only proximal thickness is significantly different ($t=-3.61$, $df=129$, $p=0.000$), with end modified microblades thicker by a mean difference of 0.3 mm.

The low coefficients of variation relative to unmodified microblades and the lack of significant differences for each continuous variable when comparing modified microblades suggest that while microblades were being selected on the basis of these metric attributes for their role as a tool blank, this selection was of a general nature, and did not reflect specific selection for modification type. This further supports the argument made here that microblades suitable for specific uses (i.e., end vs. lateral edge use) cannot be reconstructed by the archaeological analyst on the basis of these continuous variables, and that selection was likely due in part to shape and size considerations relative to that imposed by the armature or haft being considered.

Differences in segment percentages among modification types were explored. Figure 7.33 shows segment percentages by modification type. End modified microblades are clearly different than laterally modified microblades, evenly represented by proximal, medial, and distal segments with only 26% on medial segments. All laterally modified categories exhibit a similar pattern, with the majority (between 56 and 74%) on medial segments. While 6% of the end modified microblades were manufactured on complete specimens, none of the laterally modified microblades were on complete speecimens, and very few distal segments. A clear preference for medial segments for lateral modification is demonstrated by the Gerstle River Component 3 data.

Number of lateral edges modified was recorded for each modification category (Table 7.20). Clearly, end modified microblades are different from lateral modified microblades in that the few (23%) have one or two lateral edges modified (χ^2=99.15, df=6, p=0.000; Cramer's V=0.61); the lateral edge modification likely relates to hafting. When all laterally modified microblades are compared, they are not significantly different with respect to number of lateral edges modified (χ^2=3.24, df=2, p=0.198).

Table 7.20 Relative frequencies of number of lateral edges modified by modification type.

N lateral edges modified	*N*	*0 lateral edges*		*1 lateral edge*		*2 lateral edges*	
		N	*%*	*N*	*%*	*N*	*%*
End modification	31	24	77.4	6	19.4	1	3.2
Lateral (all)	100	0	0.0	68	68.0	32	32.0
Lateral major damage	34	0	0.0	27	79.4	7	20.6
Lateral minor damage	35	0	0.0	21	60.0	14	40.0
Lateral retouch	31	0	0.0	20	64.5	11	35.5

Modified microblades exhibit no significant differences with unmodified microblades with respect to number of arrises and cross section (see above). Modified microblades are different with respect to segment proportions (χ^2=17.18, df=2, p=0.0002, Cramer's V=0.13), with higher frequencies of medial segments (56.0% vs. 34.8% of unmodified microblades). With regards to qualitative shape considerations, end modified microblades do exhibit more variation in terms of parallel-ness of lateral edges than laterally modified microblades (Figures 7.29-7.32).

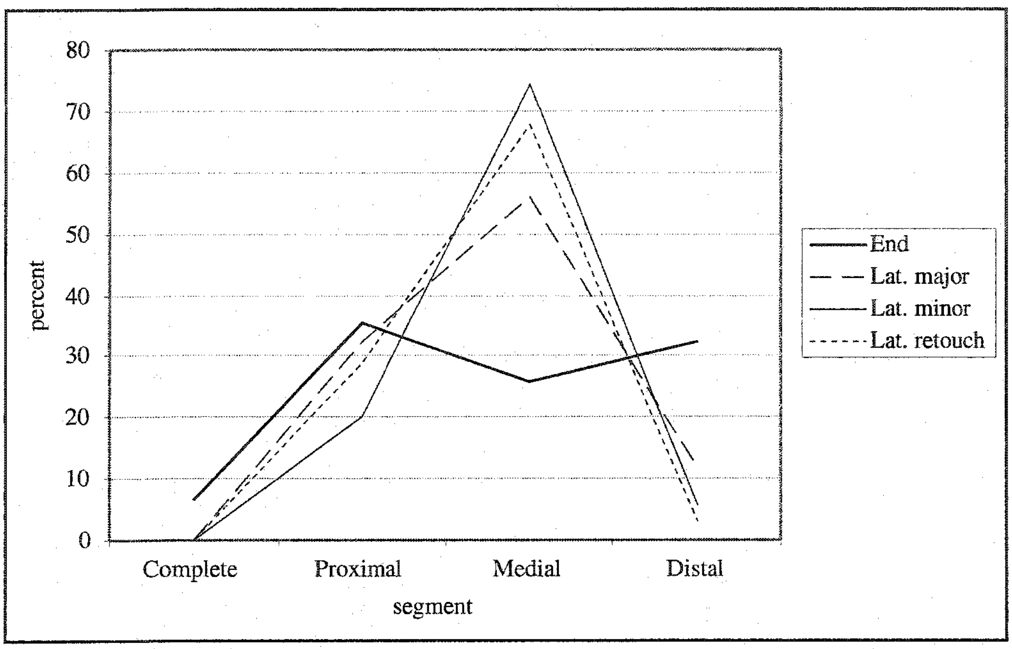


Figure 7.33 Component 3 microblade segmentation by modification type.

End modified microblades were examined for differences in length/width index and worked edge angle relative to the long axis of each specimen (Table 7.21). ANOVAs were conducted for all groups (including unmodified), revealing significant differences in L/W index (F=3.03, df=1345, p=0.048). However, no significant differences were revealed among modified groups (F=1.51, df=133, p=0.202) or between end and lateral (combined) modified groups (t=-0.78, df=129, p=0.438). Therefore, technological preferences for length relative to width is reflected at the level of modified vs. unmodified microblades, but not within microblade modification groups. Worked end angle, calculated as average angle of modified end axis from the long axis of each specimen in intervals of 2° (derived from photogrammetric analysis), was examined in two ways, one in terms of absolute value, the other in terms of divergence from 90°, accounting for left and right angled ends. Average angle is 92°±14°, and average divergence from 90° is 10°±10° (Figure 7.34). No preference was seen for points or highly skewed edge angles on end modified microblades, but instead for a flat (90°) end, generally the full width of the microblade. While tentative, the variability suggests that standardization for a working edge about 10° off of 90° is reflected. This may indicate that end modified microblades were used for a narrow range of related tasks with respect to direction of movement and material worked given the limitations discussed above.

Table 7.21 L/W index for Component 3 microblades by modification type.

Type	*N*	*L/W index*	*cv*
End modification	31	225±85	37.8
Lateral modification	100	211±87	41.2
Lateral major	34	204±83	40.7
Lateral minor	35	234±84	35.9
Lateral retouch	31	234±90	38.5
Unmodified	1215	192±100	52.1
Total	1346*	195±99	50.1

* note four items without length and/or width measurements are excluded.

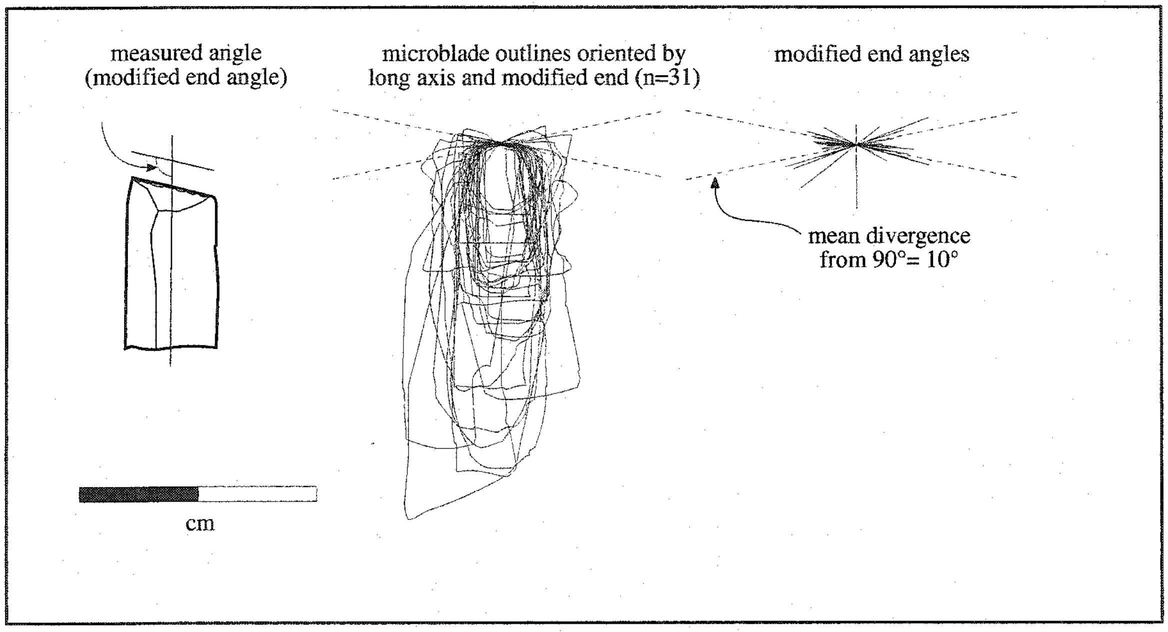


Figure 7.34 Component 3 end microblade working edge axis angle relative to long axis.

Burins (n=3)

Three specimens from Component 3 are classified as burins (Figures 7.35 and 7.36). All three specimens are made on flakes. Outlines are irregular, but generally rectangular in form. Two of the specimens are burinated on lateral margins, the third on the distal margin. Only one has multiple burinations (UA2002-62-602). As Powers (1983:114-115) notes, the morphological differences between burins and microblade cores can be ambiguous, and burins are generally recognized on the basis of damage in the form of crushing on the burin facet edge. Unifacial retouch is present on the opposite margin of the burin facet on the two larger specimens, and on both lateral edges of the distally burinated specimen. Platform preparation differs for each specimen, but generally consists of unifacial retouching on the dorsal face. No noticeable notches common to so-called Donnelly Burins were evident, though a number of burin spall platform remnants were missing due to subsequent retouch. All three appear curated and were from extremely rare material types: two are made of brown chert (n=5 for Component 3), and one is made of a unique thinly banded gray chert dissimilar from the other gray cherts. Two of the burins are similar in dimension, but with very different wear patterns. The third is relatively thin and may represent another type with respect to function. Following Mauger's (1970) defining characteristics of the Donnelly Burin type, two and perhaps all of the three specimens from Gerstle River Component 3 would fall under this type. They are manufactured on flakes with unifacial retouch adjacent to the burin platform, and usewear along the burin edge and flake face suggestive of a transverse scraping motion (see Mauger 1970).

UA2003-54-919 burin

This specimen is tentatively classified as a Donnelly burin, made on a thick flake of gray chert (C1) measuring 30.1 mm long, 23.0 mm wide, 7.5 mm thick, weighing 6.5 g (Figures 7.35 and 7.36). The platform of the original flake is salient with an errailure scar. Unifacial usewear consisting of microflaking extends along the left lateral dorsal edge. Minor usewear is present on the truncated distal end. Numerous hinge fractures forming a notch are evident on the right proximal edge of the flake that may have served as the platform for a burin blow oriented along the right lateral edge of the flake. In addition, steep unifacial usewear is evident perpendicular to the long axis of the flake, which may have removed the proximal end of the burin facet. No ventral bulb of force is present now on the facet, but usewear in the form of minor crushing and chipping is evident on the left lateral edge of the burin facet and the ventral flake surface, with a working edge angle of 70° (Cook's quadrants 3 and 4). The burin was apparently used in a scraper like motion (parallel to the burin facet's long axis), and most of the damage occurred at the proximal end of the facet, with a working edge angle of 98° (Cook's quadrant 1). The burin facet measures 27.3 mm long and 8.6 mm wide. This specimen is tentatively classified as a Donnelly burin (using Mauger's 1970 definition, not West 1981 more extended definition) because of the nature of the speculated platform preparation.

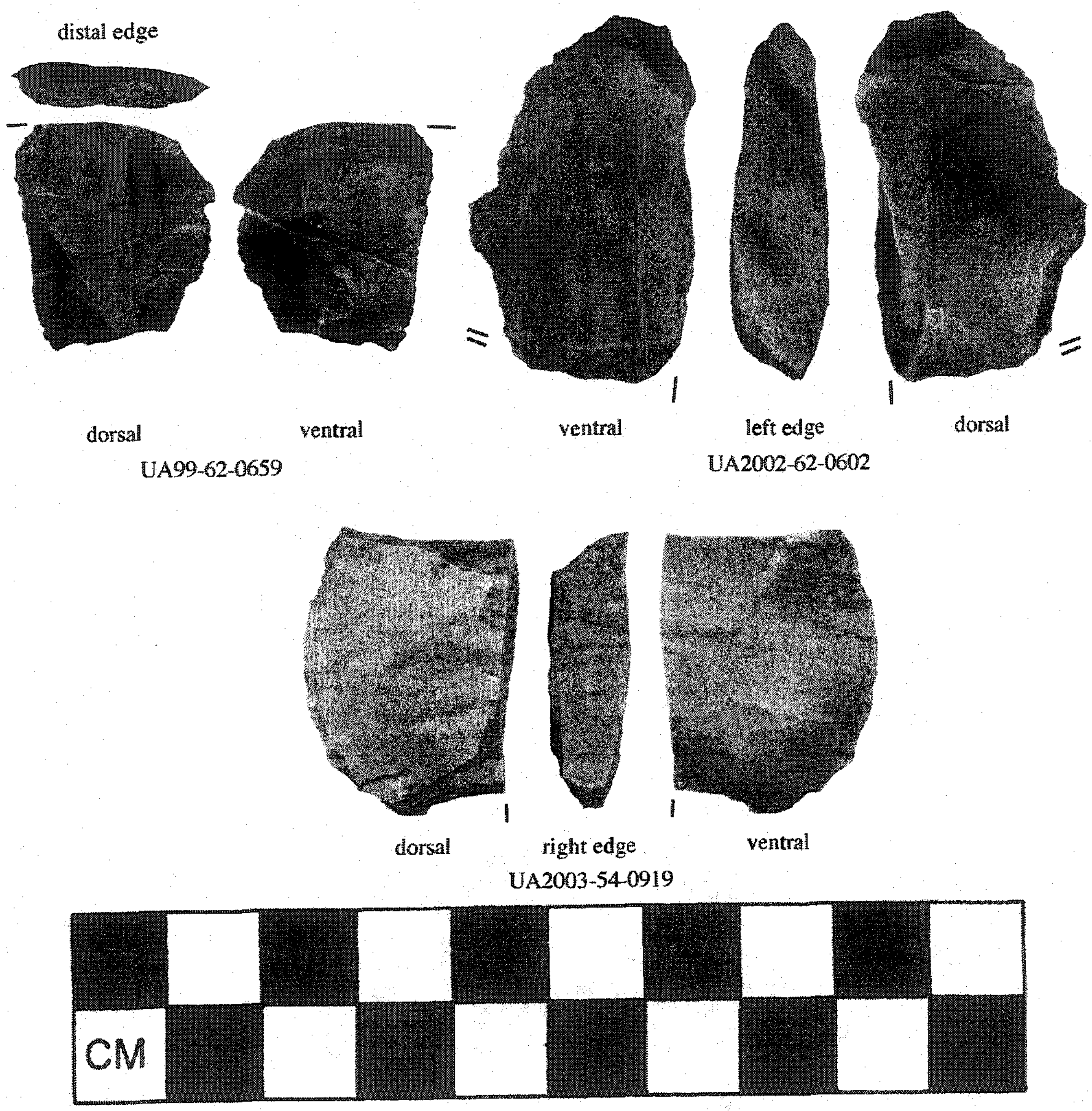


Figure 7.35 Component 3 burins.

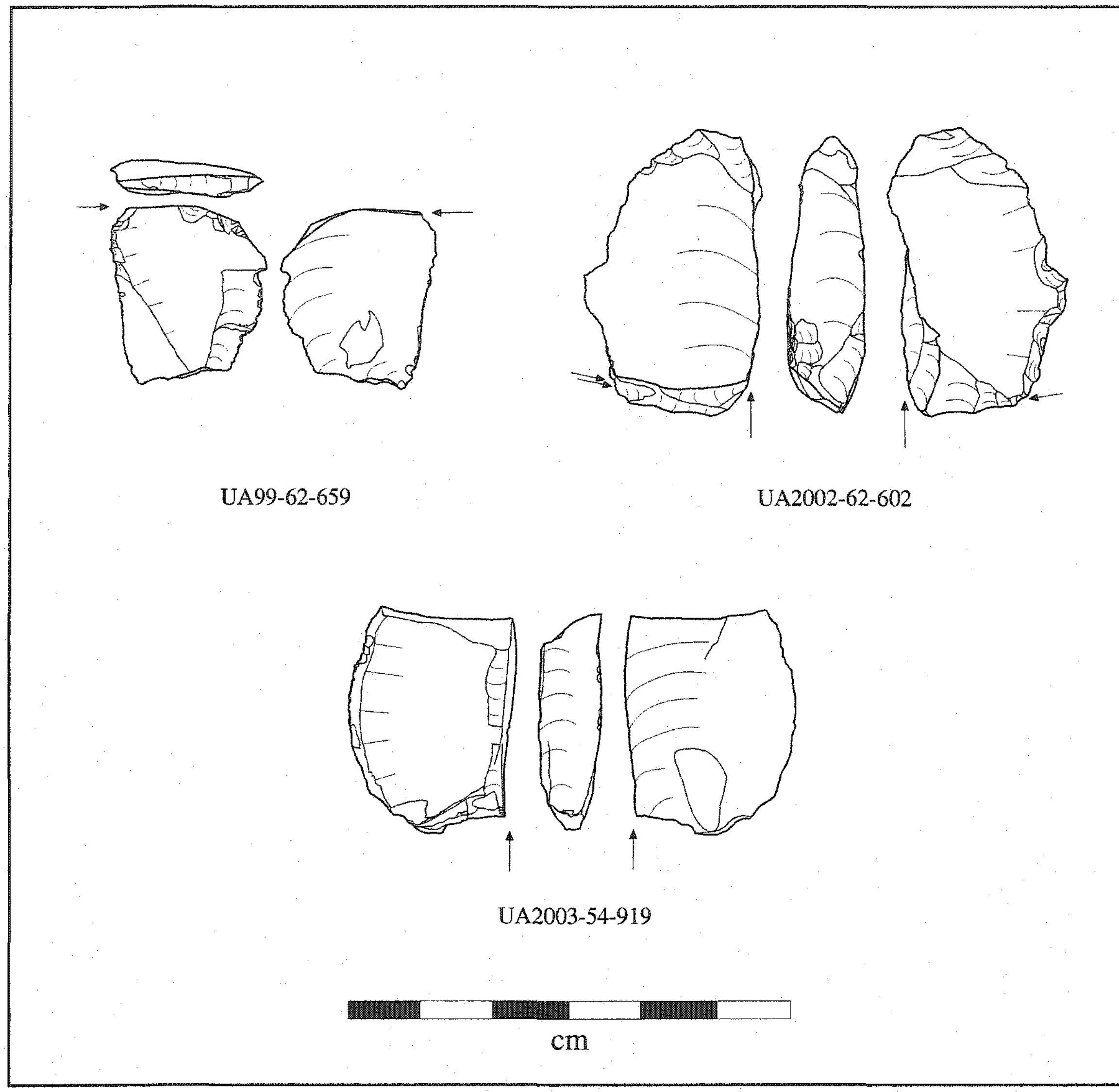


Figure 7.36 Component 3 burin line drawings.

UA2002-62-602 burin

This specimen is classified as a Donnelly burin, made on a thick flake fragment of brown chert (C6) measuring 38.7 mm long, 24.1 mm wide, 9.4 mm thick, weighing 8.9 g (Figures 7.35 and 7.36). The platform of the original flake is absent, and unifacial retouch is present on the left ventral edge. The right edge exhibits alternating retouch on both dorsal and ventral surfaces, and a projection extends 3.3 mm from that edge, shaped by dorsal unifacial retouch on all sides. Steep endscraper like retouch is apparent at the right proximal corner of the flake, with an edge angle of 75°. One burin facet is oriented from right to left across the proximal edge. The steep retouch formed the platform from which one and possibly two burin spalls were detached. The burin facet measures 5.8 mm at maximum width and 17.2 mm long, terminating at the left proximal shoulder of the flake. No burin wear is evident on this burin scar or an earlier removal from the same direction. The second earlier scar remnant is 18.1 mm long. These scars removed the platform and negative bulb of the largest burin scar, oriented laterally on the left edge of the flake. This burin facet measures 32.8 mm in length and 10.4 mm in width, ending in a severe hinge fracture near the distal end of the flake. Heavy wear is localized on the left proximal edge of the burin scar, and adjacent to the ventral flake surface (Cook's quadrant 1 [1969:105]). This wear is characterized by numerous small hinge fractures and two larger flake removals extending 7.5 mm from the proximal edge of the burin facet. The working edge formed by the burin facet and the ventral flake surface is 60°; the two larger flakes extend 7 mm from the burin facet edge. This specimen could also be classed as a transverse burin given the orientation of one of the burin facets.

UA99-62-659 burin

This specimen is classified as a transverse burin based on facet orientation, made on a flake of brown chert (C6) measuring 25.2 mm long, 20.8 mm wide, 4.5 mm thick, weighing 2.6 g (Figures 7.35 and 7.36). The specimen is unifacially retouched on the right lateral dorsal edge. Alternating retouch is evident on the left lateral edge, dorsal on the distal end and ventral on the proximal end. The burin was struck across the distal margin of the flake, and the burin facet extends 12.6 mm, ending in a hinge fracture. The proximal end and negative bulb is missing, removed by dorsal unifacial retouch at the left distal edge. Given this retouch, platform preparation cannot be reconstructed, however given the thinness of the flake and the presence of unifacial retouch along most lateral edges, the burin spall was likely struck from a unifacially retouched prepared platform. Wear on the burin facet is minor, and is limited to the left edge/dorsal surface (Cook's quadrants 3 and 4), with a working edge angle of 90°. Another possible burin facet is present on the proximal edge oriented perpendicular to the flake's long axis and parallel to the primary burin scar, partially removing the original flake platform. No negative bulb is present, and this too may have been removed by later unifacial retouch on the right proximal edge.

Burin Spalls (n=32)

Of the 32 burin spalls recovered in Component 3, 17 are primary burin spalls, and 15 are secondary burin spalls, with 13 having one, one with two, and one with three previous burin scars on their dorsal surfaces (Figure 7.37). Twenty-nine of the burin spalls show wear (91%), typified as crushing/flaking (n=26) and flaking (n=3). Length of retouch varied among the burin spalls, averaging 12.2±7.3 mm. Percentage of retouch length of total length is 65.2±30.9%. No patterns were observed in length of retouch, type of retouch, retouch as percent of total length, platform preparation, edge angle, and termination that could indicate sub-groups within the general category. Position of damage were entire dorsal edge (n=13), proximal dorsal edge (n=6), distal dorsal edge (n=5), and medial dorsal edge (n=5, two of which had localized damage). Angle of edge damage ranged from 20° to 100°, all but three were clustered between 60 and 100° with an average of 75°±18°.

Most specimens were complete flakes (69%), followed by distal fragments (22%). Lengths of complete specimens (n=22) average 22.0±6.3 mm, proximal widths average 4.1±1.0 mm, and maximum widths average 4.5±1.0 mm. Half of the platforms are prepared through microflaking or grinding, the other half are unprepared single facet platforms. Feather terminations dominate (n=20, 63%), with lesser frequencies of snap/break (n=6), hinge (n=3), and overshoot (n=2) terminations. Burin spalls can generally be distinguished from microblades by thickness relative to width (see Figure 7.38). Component 3 burin spalls have a thickness:width ratio of 58±37 (n=32) compared with Component 3 microblades, 24±7 (n=1,346), significantly different (Mann-Whitney U=4988.5, p=0.0001)

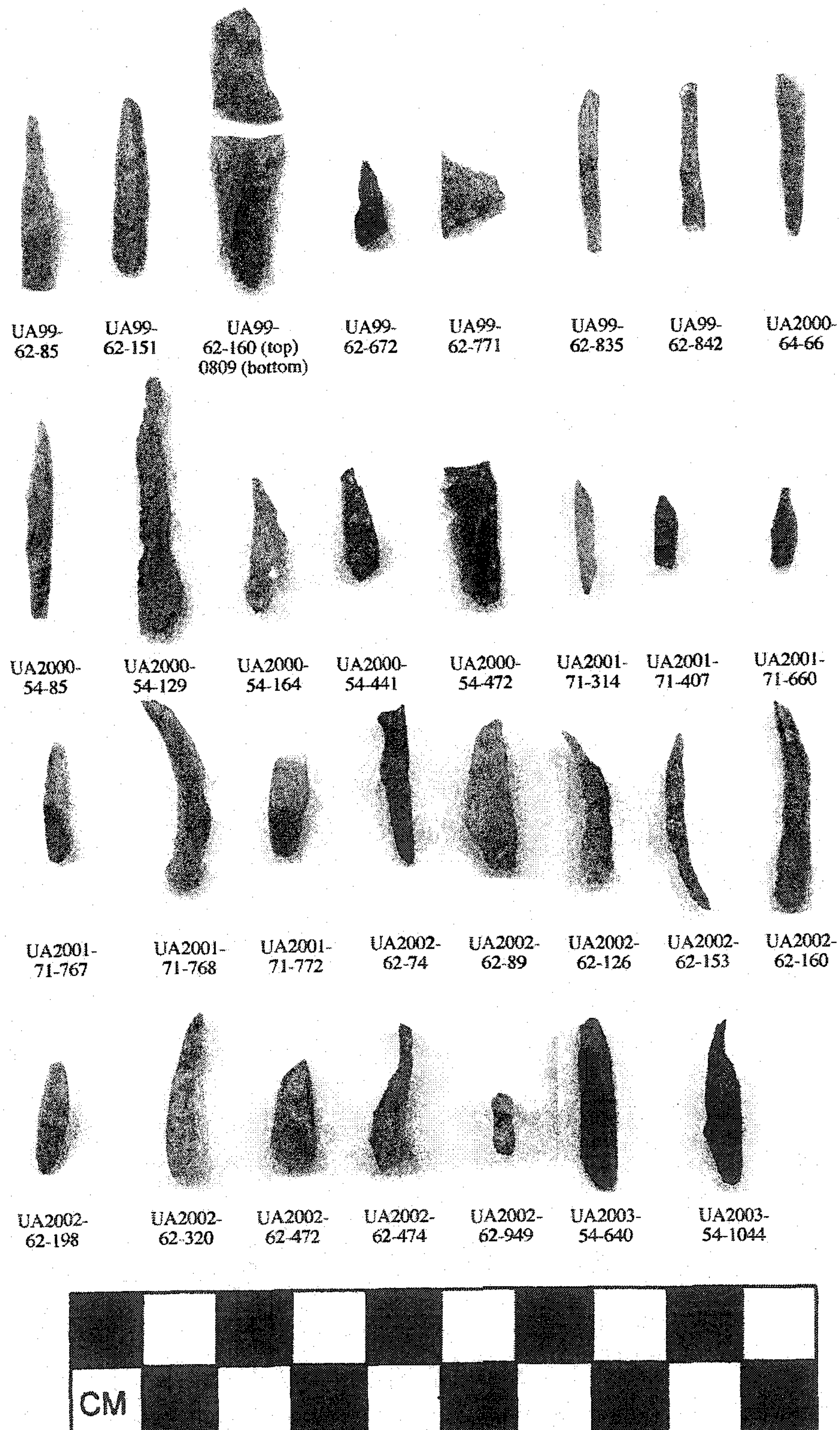


Figure 7.37 Component 3 burin spalls.

The variability of burin spall width is much less than microblade width. The difference between proximal (measured just below the bulb of force) and maximum widths and thickness differ between complete and proximal specimens of these categories. Of 21 burin spalls, 6 (29%) have some difference between maximum width and proximal width, averaging +2.31±1.65 mm. By comparison, of 541 microblades, 50 (9%) have some difference in width, averaging +1.05±0.85 mm. Thickness differences show a similar pattern, with 33% of burin spalls exhibiting a difference, averaging 1.14±0.71 mm, compared with 2% of microblades, averaging 0.36±0.27 mm. These data, along with the type of wear, reinforce the consensus that burin spalls were probably not used as tools themselves, but were used in burin manufacture or in resharpening unifacially retouched implements.

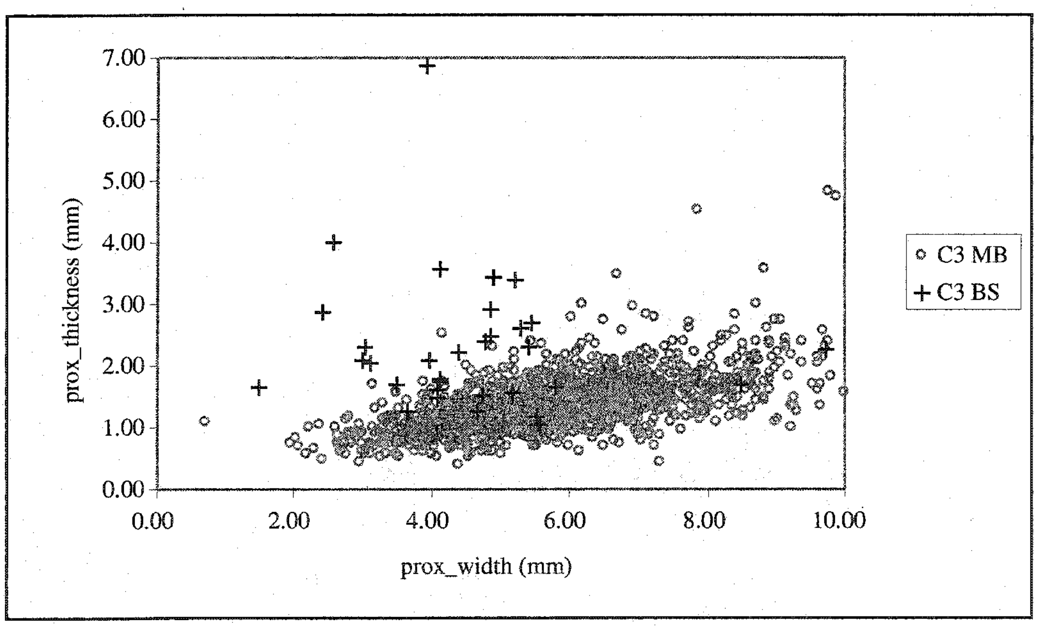


Figure 7.38 Component 3 burin spalls and microblade width and thickness.

Unifaces (n=5)

Unifaces recovered at Gerstle River Component 3 (n=5) are classified as short-axis beveled flakes (n=3), and long-axis beveled flakes (n=2), following Morlan (1973a:20-23), Gotthardt (1990), and Mobley (1991) (Figures 7.39-7.40) (see discussion in Methods).

Short-axis beveled flakes (n=3)

General characteristics of the short-axis beveled flakes found *in situ* in Component 3 (n=3) are steep unifacial retouch on the distal or in one case, proximal, end of a flake or blade, convex edge shape, and edge angles of 50°, 60°, and 80° (Figures 7.39-7.40). Two of the specimens share similar characteristics of manufacture and retouch (UA99-62-107 and UA2002-62-877) while the third specimen is distinctive with a higher use angle (80°), retouch around the entire circumference, straight/slightly convex working edge shape, and heavier overall damage (implying use against a more resilient substance).

UA99-62-107, short-axis beveled flake, burinated

This specimen is manufactured from a thick blade of very fine grain homogeneous dark gray-brown chert (C6) (Figures 7.39-7.40). Maximum dimensions are 51.4 x 16.3 x 7.2 mm with a weight of 7.1g. Classed as a short-axis beveled flake, it has a convex working edge shape, with unifacial retouch and damage extending for 16.8 mm across the proximal end of the blade and 15.3 mm working edge diameter. The cross-section of the specimen at its working edge is plano-convex. The thickness of the specimen at its edge is 7.0 mm, and the angle of utilization is approximately 60°. The specimen is burinated transverse to its longitudinal axis across the worked edge. Due to this burination, it is difficult to measure the precise edge angle of the short-axis beveled flake. The burin scar (4.2 mm wide) extends across the entire face, struck from the right proximal corner and continuing down the left proximal shoulder. Very minor wear is evident on the left proximal ventral edge on the burin facet, but the implement was not used as an end scraper after the burin blow was struck. Typical end scraper retouch was evident (flake scars from 1-3 mm in width) from the remnant flake scars above the burin scar. The short-axis beveled flake was most likely hafted, as there is damage on the right distal edge and polish on the dorsal arris.

UA2002-62-877 + UA2003-54-215, short-axis beveled flake

This specimen is manufactured from a very thick distal fragment of a blade of fine grain black chert (C4) (Figures 7.39-7.40). Maximum dimensions are 24.3 x 13.2 x 10.3 mm, with a weight of 2.8 g. The cross section approaches an equilateral triangle, though the cross-section at its working end is plano-convex through retouch. Retouch is limited to the distal end. This short-axis beveled flake has a convex working edge shape, with unifacial retouch and damage extending for 16.7 mm across the distal end of the blade with an working edge diameter of 11.4

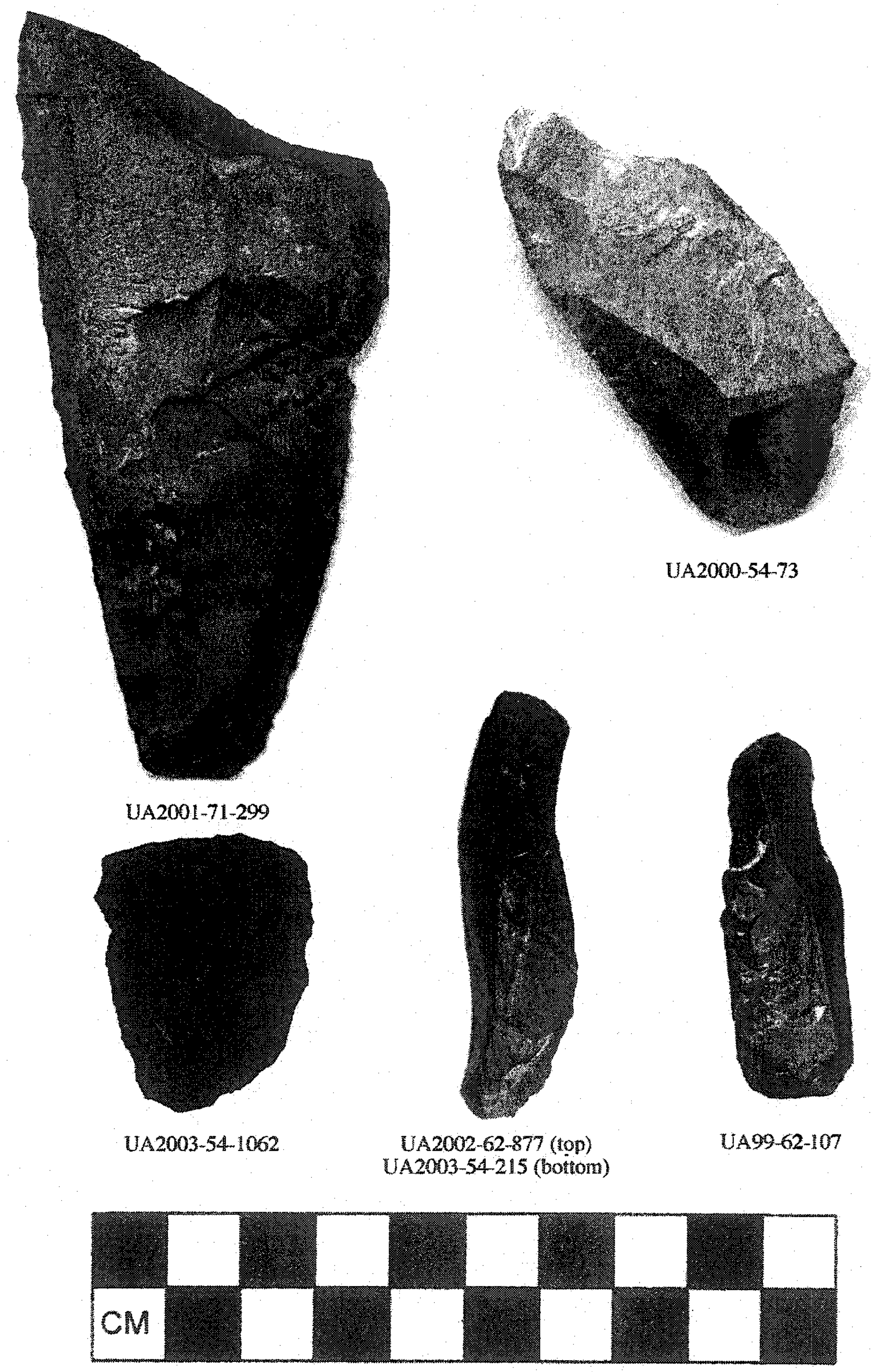


Figure 7.39 Component 3 unifaces.

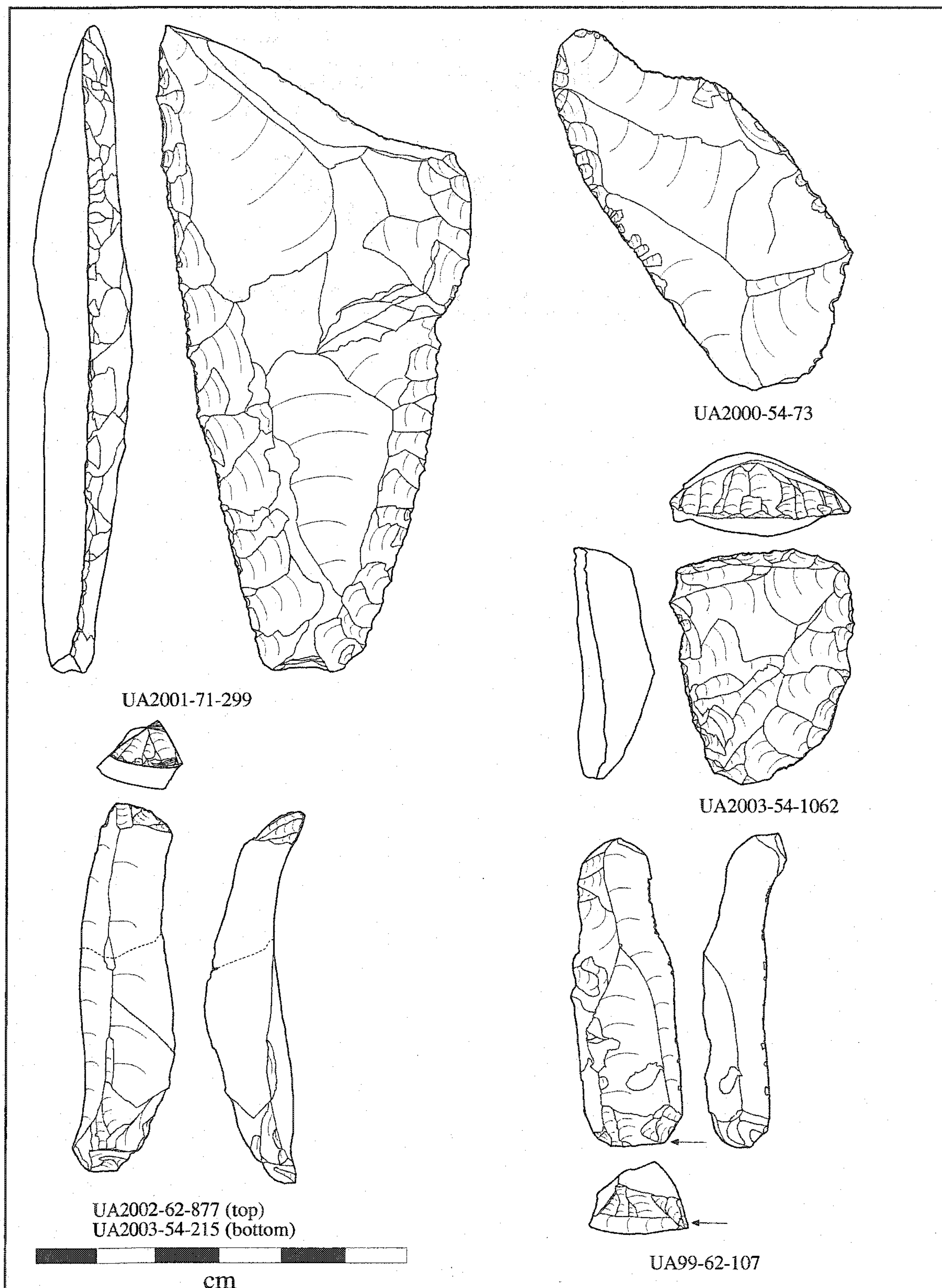


Figure 7.40 Component 3 uniface line drawings.

mm. The thickness of the specimen at its working edge is 6.9 mm, and the angle of utilization is approximately 50°. Multiple hinge fractures, minute flake scars, edge crushing, and edge polish are evident on the working edge. Retouch is confined to the distal worked end, though a few small microflakes on the right medial edge may relate to hafting damage (though there is no polishing evident on the dorsal arris). This short-axis beveled flake refits with UA2003-54-215, the proximal portion of the blade, which extends the total length of the implement to 60.2 mm, with a width of 15.9, and maximum thickness to 11.9 mm, with a total weight of 12.8 g. Intermittent microflaking extends down both lateral edges, and there are numerous step fractures at the proximal dorsal face. The arrises are polished, indicating that the implement was hafted. Damage to the dorsal arris indicates that the blow that broke the blade was initiated at that point.

UA2003-54-1062, short-axis beveled flake

This specimen is manufactured from a thick flake of fine grain black chert (C4) (Figures 7.39-7.40). Maximum dimensions are 38.4 x 29.5 x 11.5 mm, with a weight of 14.6g. The cross section is plano-convex on the working end, and the specimen is unifacially retouched on all edges. The short-axis beveled flake has a straight/slightly convex working edge shape, with unifacial retouch and damage extending for 29.7 mm along the distal end of the flake, with a edge diameter slightly less (25.9 mm). The thickness of the specimen at its working edge is 9.3 mm, and the angle of utilization is 80°. This specimen is more heavily damaged than the others, with many hinge fractures on the beveled edge and a number of flake scars on the adjoining ventral surface. Microflaking and hinge fractures extend around the circumference of the specimen, but is most pronounced on the distal end. Polish on arrises is evident from the proximal end to the distal (used) end, implying hafting.

Long-axis beveled flakes (n=2)

UA2000-54-73, long-axis beveled flake

This specimen is classed as a double side scraper and is manufactured from a relatively thin blade-like flake of gray chert (C1) (Figures 7.39-7.40). The platform is still present, and does not exhibit platform preparation indications. Maximum dimensions are 68.2 x 29.9 x 8.6 mm, with a weight of 14.3g. The specimen exhibits unifacial retouch on both lateral edges, 34.7 mm on the right edge, and 39.8 mm on the left edge that includes some of the distal end. Both working edges are straight, with edge thickness of 3.6 mm on the right and 2.4 mm on the left.

Angles of utilization are the same for each edge, at 35°. Damage consists of microflaking and minor hinge fracture scars, rarely extending for more than 3.8 mm from the edge. This specimen is very similar to another double side scraper found in disturbed contexts of the same material (UA2001-71-21).

UA2001-71-299, long-axis beveled flake

This specimen is classed as a long-axis beveled flake (Figures 7.39-7.40), more traditionally termed a convergent side scraper, and is manufactured from a very large flake of dark grayish-brown argillite (Ar). The platform is no longer present, and the original flake hinge termination is observable. A large hinge scar is evident on the distal-dorsal surface; that flake was struck from the opposite direction. Maximum dimensions are 107.1 x 49.6 x 13.1 mm, with a weight of 63.1g. The medio-proximal cross section is plano-convex due to uniform retouch on both edges. Length of retouch on the left and right lateral edges is 106.0 mm and 88.3 mm respectively. The specimen exhibits relatively even unifacial retouch on both lateral edges (excluding the hinged distal end). Shaping flake average around 4 mm. Both working edges are straight, with edge thickness of 7.2 to 7.7 mm on both utilized edges. Angles of utilization are remarkably uniform, with 40°±5° on both worked edges. Damage consists of microflaking and minor hinge fracture scars, rarely extending for more than 2 mm from the edge. Damage is much heavier on the left lateral edge than the right, which exhibits very few hinge fractures or crushing damage. The left edge is the longer and straighter of the two utilized edges. Polish is exhibited on the prominent dorsal arrises. The left lateral and distal edges come to a point, where polish is evident on the tip, and multiple overlapping hinge fractures are evident within 1.3 mm of the tip on the left lateral edge. The point was therefore likely used as well as both lateral edges. Minor damage consisting of a few microchip scars appears on the ventral-distal edge of the implement and may not relate to usewear damage. This uniface is different from all of the other implements with retouch on their lateral edges, in that the retouch has is generally uniform (4 mm flake scar widths) and extend around the tool excepting the distal end.

Convergent side scrapers are known from Denali Tradition contexts, such as Dry Creek Component II (Powers 1983). Most of the Dry Creek convergent side scrapers have rounded bases, this side scraper is more in the shape of an scalene triangle. The most similar specimens at Dry Creek CII can be seen in Powers (1983: 164: Fig. 4.42, B).

Bifaces (n=2)

Two bifaces were recovered at Gerstle River Component 3, a complete rhyolite biface and a small gray chert biface fragment (Figures 7.41-7.42).

UA2003-54-1049

This specimen is a nearly complete biface of white rhyolite (R2), measuring 70.3 mm long, 34.3 mm wide, 10.8 mm thick, and weighing 26.7 g (Figures 7.41-7.42). The outline is lanceolate with excurvate lateral edges. The cross-section is lenticular. The specimen is symmetrical in outline and in cross section. The edge angles are about 50°. The flaking orientation is generally random and extends across both faces, but beveling is observed on one lateral edge. Flake scar outlines are generally parallel, and about 7 mm wide. The "tip," inferred as such by the decreasing thickness of the piece in this area, exhibited flaking parallel to the lateral edges. The specimen is much thinner near the tip (5.3 mm at 15.0 mm below the tip vs. 10.8 mm at midpoint) and fresh flake scars (lateral edges are sharp with no grinding or polish), suggesting that the implement may have served as a projectile point and was reworked after impact damage had removed a portion of the tip.

The opposite end, or "base," was broken perpendicular to the long axis, likely the result of breakage during maintenance, geared for thinning or reshaping the base. This break occurred after its use, as there was no use-related wear on this scar, and likely led to its discard. Tiny (<1mm) scars suggesting abrading were observed on the edge of this scar and one face. No similar scars were found on the opposite edge/face. Three shallow flake scars were found near the base up to 1/3 the length of the specimen that were aimed at removing a bulge located about 9 mm from that lateral edge. These flake scars and previous scars exhibited hinge terminations at this bulge. No edge grinding was observed, however, there was polish located on both lateral edges, from the base to 1/2 of the length. One side was apparently covered with red ochre. Unifacial beveling is seen on one lateral edge for about 27 mm near the tip, which could suggest use of this implement as a scraper or shaver (unidirectional movement). This specimen was found in a small cluster of white rhyolite flakes (n=79), suggesting maintenance prior to discard.

A plausible scenario for the use-life of this specimen is production as a lanceolate projectile point, followed by impact damage that removed part of the tip. Subsequent use was as a scraper or shaver. Following this use, the specimen was thinned at the base, and resulting excessive hinging and removal of the base led to its discard. The final stage of maintenance and

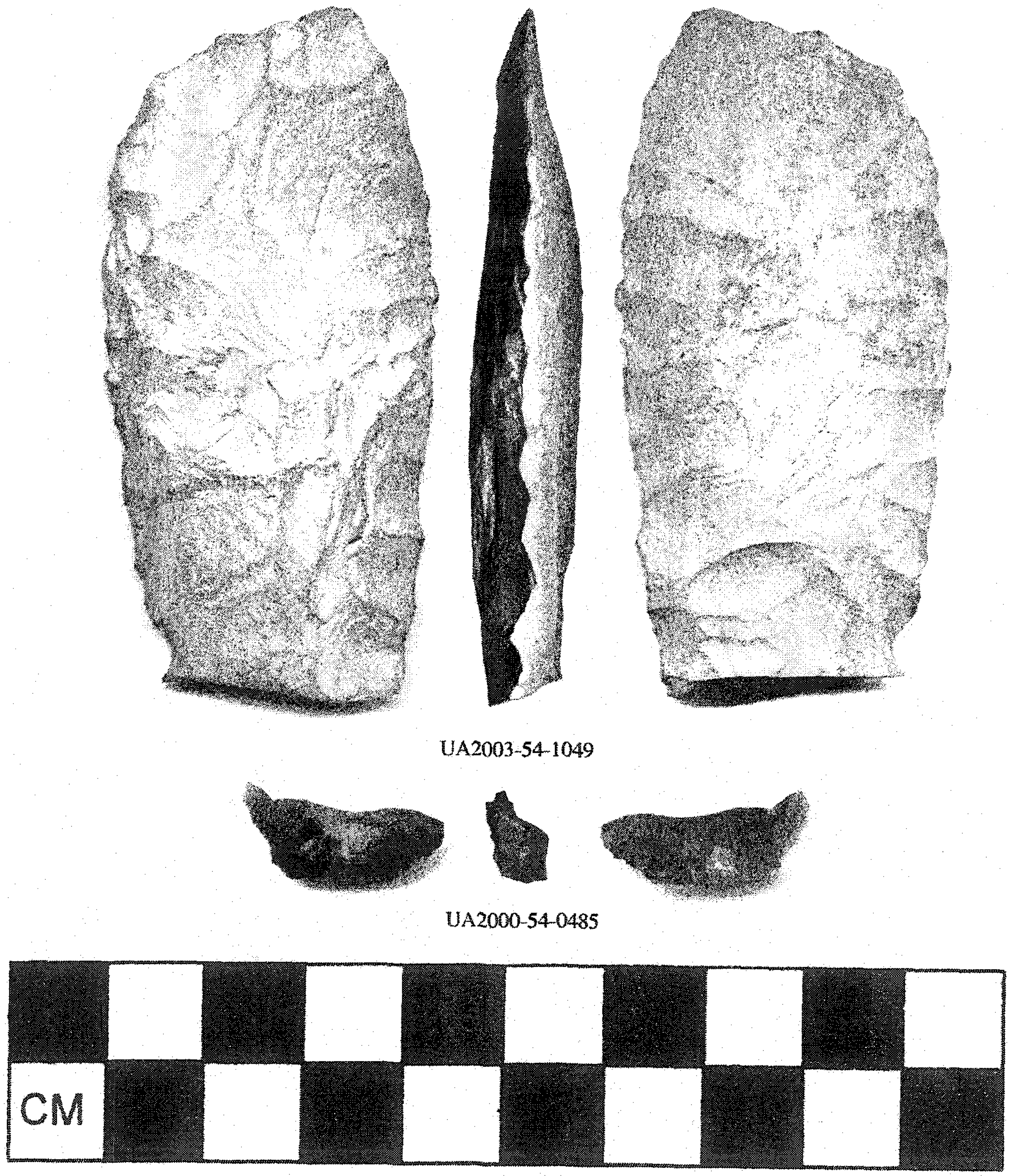


Figure 7.41 Component 3 bifaces.

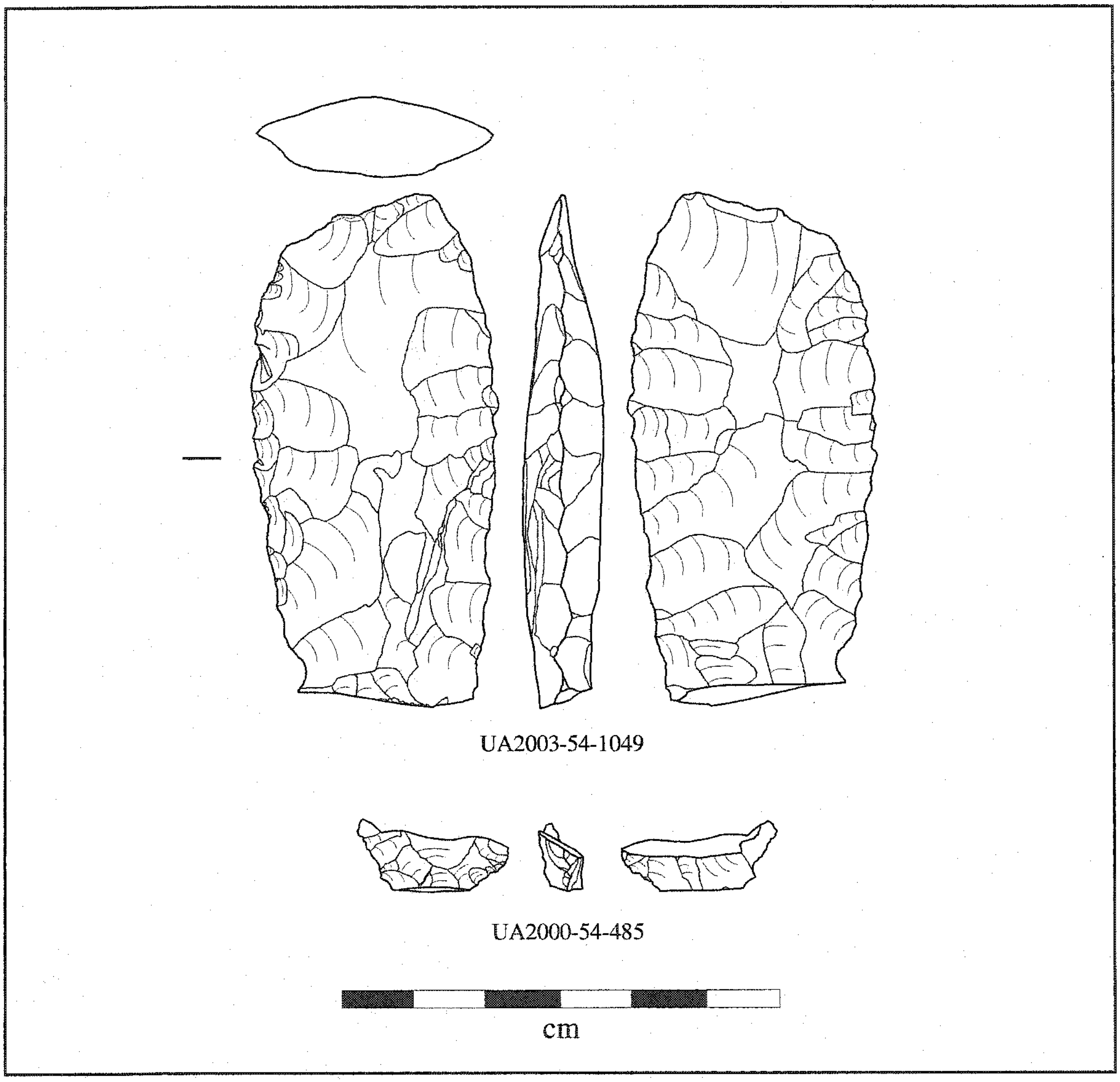


Figure 7.42 Component 3 biface line drawings.

perhaps use as a scraper likely occurred in the area of its recovery given the non-microblade related rhyolite flakes found nearby.

UA2000-54-485

This specimen is a small biface fragment of gray chert (C1), measuring 8.8 mm long, 21.2 mm wide, and 5.7 mm thick, and weighing 0.8 g (Figures 7.41-7.42). This fragment is classed as a biface due to the presence of bifacial retouch on one lateral edge, but not enough of the other edge remains to determine what the original form was. The piece appears to have fractured along bedding planes, and both the top and bottom are flat and smooth.

Modified flakes (n=67)

Sixty-one flakes with some form of secondary modification were recovered from Component 3. As noted above, two units of analysis were used for this study, the first are individual modified flakes (n=61). Given that a number of these specimens have different types and locations of damage, a second unit of analysis was used, termed modification unit (n=97). Modification units were demarcated on the basis of separate physical locations on the item (i.e., each margin or arris).

Extensive refitting analysis on all modified specimens revealed conjoins among 14 modified flakes and flake fragments, totaling seven modified flakes. The data for UA2002-62-449 includes UA2002-62-105; UA2002-62-1139 includes UA2002-62-893 and 1138; UA2003-54-1079 includes UA2003-54-1080; UA2003-54-793 includes UA2003-54-811; and UA2002-62-322 includes UA2003-54-1338. Two other specimens, a gray chert flake broken into three fragments (UA2002-62-117, 259, and 302) and a siltstone flake broken into two fragments (UA99-62-93, 98) are treated separately as there are indications that further retouch took place after fragmentation. For the purposes of these summaries, these are combined into their constituents; therefore summary totals include 61 specimens (Figures 7.43a, 7.43b, and7.44).

Summary descriptions by modified flake (n=61)

Two specimens were made on primary flakes (3% of total modified flakes), eight (13%) on secondary flakes (retaining some part of the outer cortex), and the remaining 51 (83%) were made on interior tertiary flakes. Twelve (20%) specimens are made on blade blanks (mostly

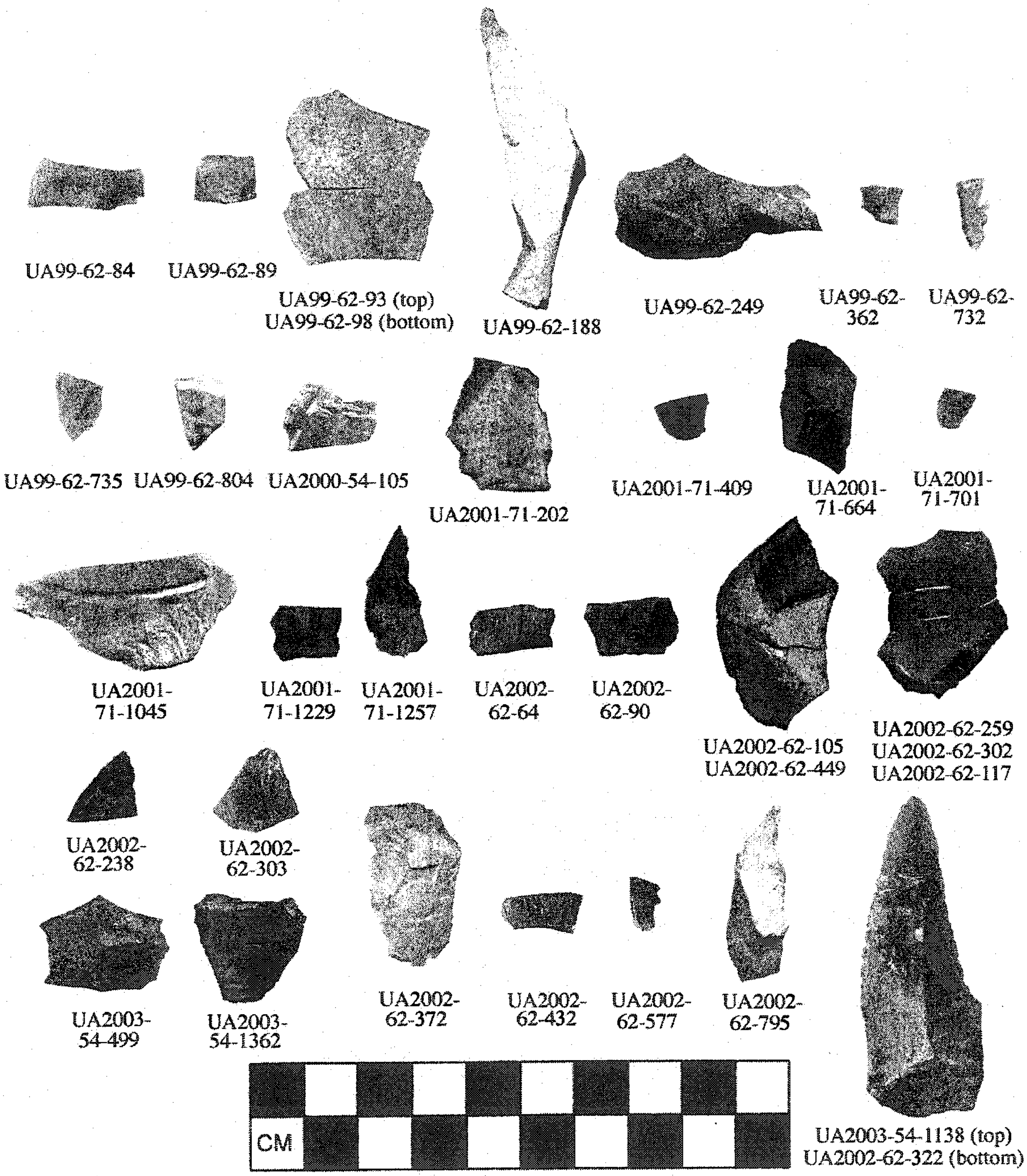


Figure 7.43a Component 3 modified flakes.

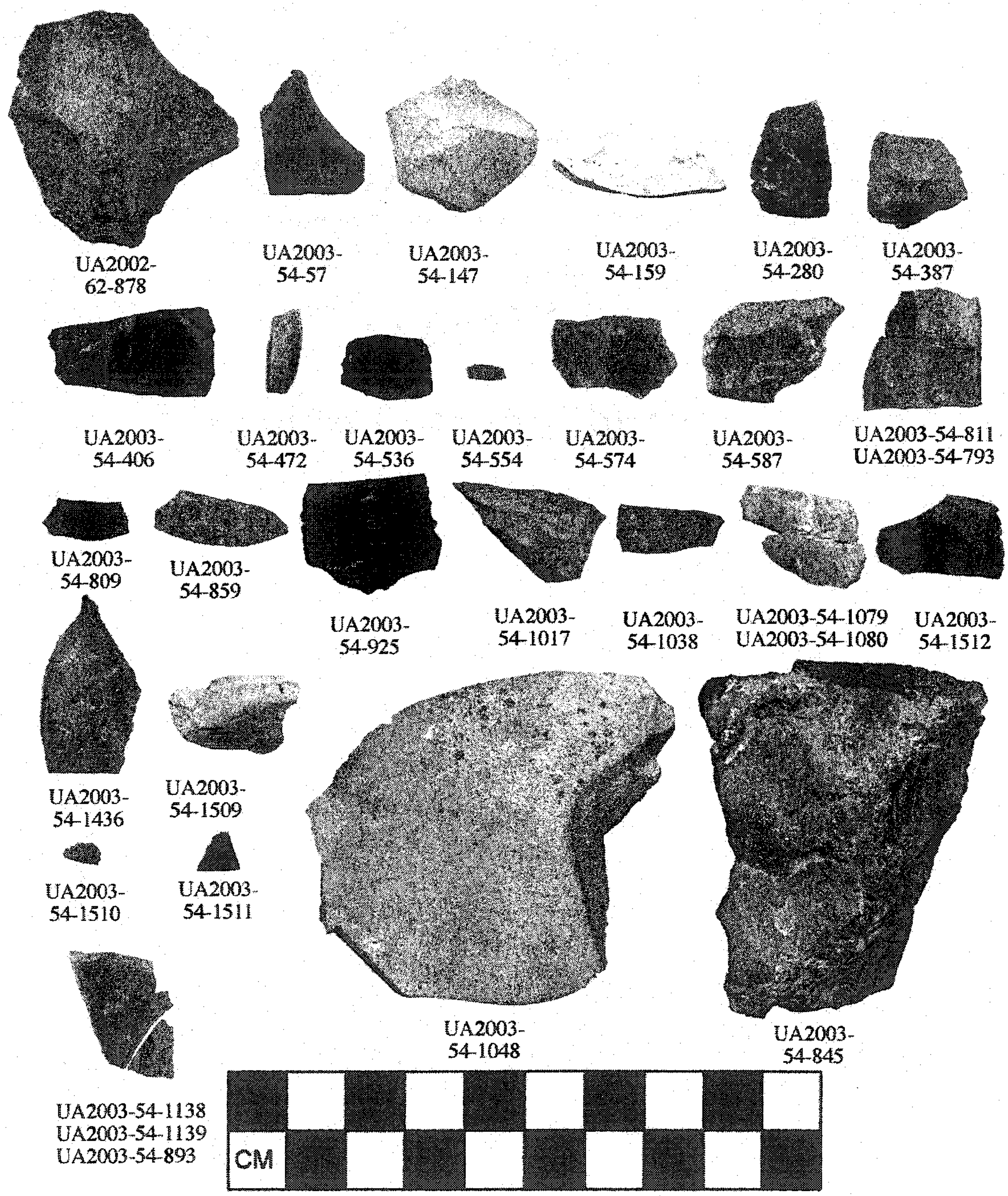


Figure 7.43b Component 3 modified flakes.

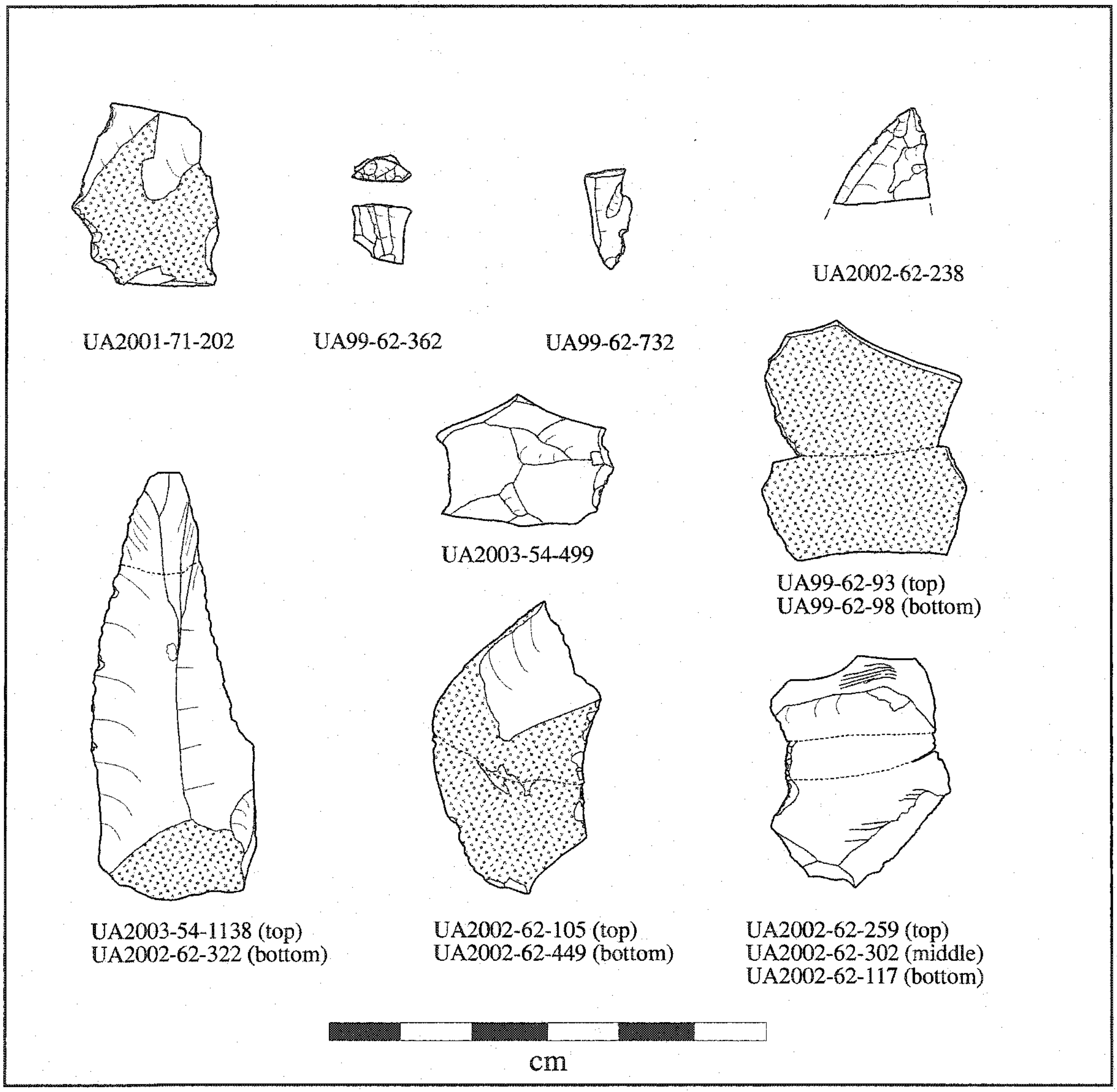


Figure 7.44 Component 3 selected modified flake line drawings.

broken), one (2%) specimen is made on shatter, and the remaining blank forms are flakes (48, 79%). Average maximum length is 19.1±13.0 mm (median=15.9 mm), average width is 19.1±10.8 mm (median=16.9 mm), average thickness is 4.0±2.1 mm (median=3.4 mm), and average weight is 2.29±4.83 g (median=1.00 g), all considerably larger than the average unmodified flake size measurements. Modified flakes were typically broken (n=45, 74%), with only 12 complete blanks (19.7%). Segment types included proximal (n=7, 12%), medial (n=22, 36.1%), distal (n=16, 26%), and indeterminate fragments (n=1, 2%). Eight material types were present, predominately C1 (n=35, 57%) and C4 (n=10, 16%). A number of exotic material types included C6 (n=2, 3%), J2 (n=1, 2%), and S (n=4, 7%).

Modification intensity included 12 classed as heavy (20%), 30 classed as moderate (49%), and 19 classed as light (31%). Predominant modification type included burin-like wear (n=4, 7%), crushing (n=6, 10%), edge damage (n=11, 18%), microflaking (n=27, 44%), polish (n=5, 8%), and retouch (n=8, 13%). Retouch was typically located on the dorsal face (n=46, 75%), with moderate frequencies on the ventral face (n=16, n%) and flake edges (n=18, 30%). The most common modification location was on the dorsal face alone (n=29, 48%) followed by dorsal-edge (n=7, 12%). Most flakes were modified on only one face (n=46, 75%), with 8 (13%) on both faces and 6 (10%) on flake edges only. The most common positions of modification on flake edges were on both left and right lateral edges (n=15, 25%), left lateral edges (n=12, 20%), and distal edges (n=12, 20%). Proximal modification was rare (n=6, 10%). The majority of these flakes are modified in one or two edge positions (n=28, 50% and n=22, 36% respectively), with lesser frequencies on three and four edge positions (n=7, 12% and n=2, 3% respectively). Edge shape ranges from pointed to notched, with the most common being straight (n=38, 62%), multiple (n=9, 15%), and convex (n=7, 12%). Predominant edge shapes are straight (n=41, 67%), convex (n=9, 15%), concave (n=5, 8%), pointed (n=4, 7%), and notch (n=1, 2%). The longest modified edge length averages 15.1±12.6 mm, and sum of modified edge length averages 20.7±18.7 mm. Percent modified margins (i.e., number of modified margins/total margins) averages 42.8±18.9%. Predominant edge angle averages 39°±26°.

Summary descriptions by modification unit (n=97)

There were a total of 97 modification units, averaging 1.6 units per modified flake, and ranging from one to four units per modified flake (30 with one unit, 28 with two units, one with three units, and two with four units). Some of the units were characterized by more than one modification type (n=11, 11%). None of the margins exhibiting burin-like wear had other modification types, but four of those exhibiting crushing had retouch damage, and of the flakes with extensive polish, two had microflaking damage, and five had edge damage; only one exhibited polish alone. Table 7.22 shows summary data on modification units by modification type. Most of the modification types showed similar dimensions; the most divergent were margins exhibiting polish with longer modification lengths and larger maximum dimensions. Three of the polished items have a pointed modified edge shape, while three are straight, one is convex, and one is concave. Margins exhibiting crushing and retouch were remarkably similar in maximum dimension, thickness, weight, and especially edge angle, higher than those margins exhibiting edge damage or microflaking. Four types of modification units are derived on the basis of these data: (1) burin-like wear with relatively high edge angles and generally straight modified edges, (2) crushing and retouch with intermediate edge angles, (3) microflaking and edge damage with low edge angles and a wider variety of modified edge shapes, and (4) polish, with higher maximum dimensions and longer modified lengths, with a tendency for occurrence on flake projections. Given the wide ranging variability in size, shape, and type and position of damage, I suspected that there were a number of functional groupings masked in this category.

Possible Groupings

In order to identify potential functional groupings of modified flakes, I examined the relationship between maximum thickness and edge angle, which may be related to type of use, or kinetic motion/action. Thinner flakes limit the application of force and can be related to a limited array of tasks (slicing, cutting of non-resilient materials, etc.). More acute edge angles likewise limit the possible types of force and motion. Thicker flakes or flakes with higher edge angles can be used for a wider range of motions (e.g., scraping, planing, others) on more resilient materials (e.g., antler, wood, bone).

Table 7.22 Summary variables by modification type.

Modification Type	*Burin-like*	*Crushing*	*Retouch*	*Micro-flaking*	*Edge Damage*	*Polish*
N	7	10	10	45	17	8
Maximum dimension (mm)	21.2±5.1	22.3±8.1	20.2±5.6	20.7±11.9	23.3±11.3	39.3±19.8
Thickness (cm)	3.5±0.9	4.7±2.1	3.6±1.5	3.5±1.9	3.4±1.4	6.6±2.1
Weight (g)	1.24±0.87	1.38±0.87	1.12±1.06	1.32±1.79	2.22±5.65	10.0±11.6
Edge angle (°)	84±8	48±24	43±19	33±23	36±28	38±18
Mod-Length (mm)	12.7±4.9	13.1±9.3	9.9±5.3	12.5±10.0	13.2±27.6	23.8±19.7
Modified edge shape	Straight-concave	Straight	Straight-concave	Straight	Straight	Varied
straight	71%	70%	60%	73%	71%	39%
convex	-	20%	-	20%	12%	13%
point	-	-	-	-	12%	39%
concave	29%	10%	40%	4%	6%	13%

Flakes were examined for patterns in maximum length, width, thickness, length of modified edge, sum of all modified edge lengths, percentage of modified margins, number of modified faces and edges, and predominant edge angle using predominant modification class as the grouping variable. Flakes with burin-like wear and crushing damage had greater percentages of retouched margins, greater numbers of modified edges, and higher edge angles compared with other modification classes. Flakes with polish were generally larger and heavier, and lower numbers of faces and edges modified than other classes. Flakes with retouch had slightly higher edge angles than other classes (mean of 40° vs. 20°) but were similar in other respects. Flakes with microflaking had lower weights but similar length and width values. Flakes with edge damage were generally larger in length and width (but with slightly lower thickness values than other classes), modification length and sum of modified edge lengths were greater, percent of modified margins were greater, and average edge angles were lower than other classes.

Modification class by blank, segment, number of modified faces and edges showed some patterning. Retouched flakes were only found on flakes (and one shatter or angular debris); none were found on blades. Edge damaged and burin-like wear was more common on medial fragments (utilizing the proximal or dorsal snapped edge). Microflaking appears to be spread evenly in all segment types. No burin-like wear or crushing was found on complete flakes. All modification classes were similar in number of modified faces (1 face (67%); 2 faces (30%); 3 faces (3%). Retouching was found on two of the three concave shaped modified edges (making up 37.5% of total retouched flakes).

One of the most interesting patterns is the relative lack of intermediate edge angles (between 40° and 70°). Figure 7.45 plots predominant edge angle by maximum thickness for each modification class. All of the modified flakes with burin-like wear are between 70° and 90°. Flakes with crushing damage are more likely to be associated with edge angles between 65° and 80°. Almost all of the edge-damaged flakes had edge angles between 10° and 40°.

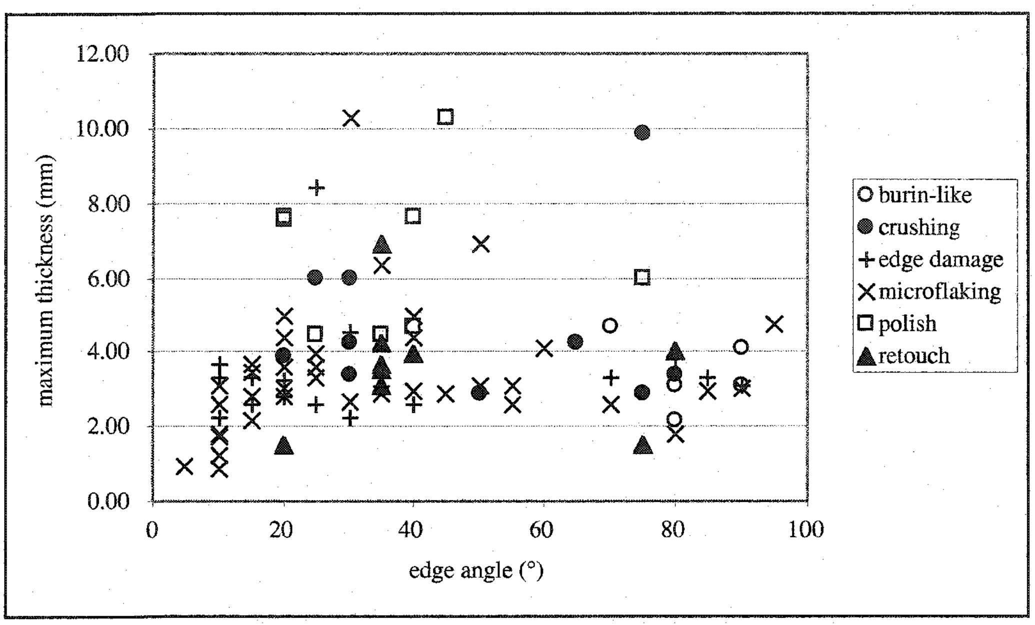


Figure 7.45 Maximum thickness and predominant edge angle by modification type.

Based on these analyses, I posit four types of modified flakes at Gerstle River Component 3; summary variables are detailed in Table 7.23.

Type A modified flakes (n=4) exhibit burin-like wear and crushing wear on a straight, steep angled edge (~80°), with a greater percentage of modified margins (perhaps relating to hafting of the implements). The sum of modified length is higher than in other types. It is possible these implements were used in a scraping or graving motion against resilient material (bone or wood), and functioned as scrapers or engravers.

Type B modified flakes (n=14) exhibit crushing or intentional retouch on generally one or two straight or concave margins. Edge angles are intermediate between Type A and Type C (~40°). These flakes may have functioned as unidirectional scrapers (e.g., spokeshaves or straight-edged scrapers), but intensity of use is considered light given the observed edge damage. One specimen, UA2001-72-202 may be a denticulate, with unifacial retouch and a toothed edge morphology (see Figures 7.43a and 7.44).

Type C modified flakes (n=38) exhibit microflaking and edge damage at lower edge angles (5°-40°, averaging 30°) with a variety of edge shapes, but predominantly straight and convex edges. These flakes may have been used to cut or slice non-resilient material (e.g., hides or meat). Given the similarities between microflaking and edge damage in edge angle and retouch length, it is possible that these were used in a similar manner, but with different frequencies of use (i.e., those with microflaking damage may have been used for a longer time). Two of these specimens (UA99-62-362 and 732) exhibit microflaking/wear on the distal edges and steep edge angles (70°, 90°), suggesting unidirectional scraping use (see Figure 7.44).

Type D modified flakes (n=5) exhibit polish on generally one edge. Flakes of this type are generally larger than other types (length averages 39 mm vs. 15-18 mm respectively), and are more varied with respect to edge shape (see Table 7.23). Almost half are found on points, and these flakes may have been used in hide processing.

A number of modified flakes are medial segments only with retouch or usewear present to the broken edges. This, coupled with their small size, suggests that many of these items were broken on-site and subsequently discarded. For example, UA2002-62-117, 259, and 302 (Figure 7.43a) refit to form a distal flake fragment measuring 31.6 mm long, 22.7 mm wide, and 3.6 mm long. Unifacial retouch along the right margin extending on to the dorsal face forms a concave edge 11.9 mm along specimens 117 and 302. This steep unifacial retouch does not extend to the most distal specimen (259) and the edge of the latter piece extends beyond the margins of the other two. UA2002-62-259 was thus broken prior to later wear on 302 and 117. This interpretation is supported by the presence of burin-like damage on the distal break of specimen 302. This type of use is common, and 54% of the modified flakes have multiple areas of use, suggesting that lithic raw material may have been conserved on-site. Certainly, the paucity of flakes greater than 2 cm in maximum dimension would support this contention.

Table 7.23 Modified flake type summary data.

Variable	*Type A Burin damage*	*Type B Retouch/crushing*	*Type C Edge damage, microflaking*	*Type D Polish*
N	4	14	38	5
Blank (blade%)	25%	7%	21%	20%
% Exotic material	25%	0%	21%	20%
Avg. length (mm)	15.1±5.4	17.9±7.3	17.3±12.4	39.4±18.2
Avg. width (mm)	20.7±6.9	17.8±7.4	18.0±10.1	30.2±20.6
Avg. thickness (mm)	3.5±1.1	4.4±2.0	3.5±1.8	7.2±2.2
Avg. weight (g)	1.4±0.9	1.4±1.0	1.7±4.0	9.9±10.9
edge shape				
point	0%	0%	0%	40%
convex	0%	7%	16%	0%
straight	75%	57%	66%	40%
concave	0%	21%	3%	0%
notch	0%	0%	3%	0%
multiple	25%	14%	13%	20%
Avg. predominant edge angle	80°±8°	39°±18°	30°±23°	37°±24°
Avg. predominant edge shape				
straight	100%	86%	71%	40%
convex	0%	14%	18%	0%
point	0%	0%	5%	40%
concave	0%	29%	3%	20%
notch	0%	0%	3%	0%
Intensity	heavy-moderate	heavy	light	light
heavy	50%	57%	5%	0%
moderate	50%	36%	34%	0%
light	0%	7%	61%	100%
∑ modified length (mm)	31.6±16.8	17.5±10.9	19.0±17.6	34.4±37.2
% modified margins	66.8±23.6	42.9±18.0	41.0±18.3	36.6±12.7
N positions (dorsal, ventral, edge)	1.8±1.0	1.4±0.5	1.3±0.5	1.2±0.4
N positions (left, right, proximal, distal)	2.8±1.0	1.8±0.9	1.6±0.7	1.4±0.5

Flake morphology is constrained by blank type and reduction sequence. While some of the modified flakes were made from blade blanks (20%), the majority were made from medium to large flakes apparently separate from the microblade industry at Component 3. Six modified flakes have remnant cortex on the dorsal faces (10%) compared with none in the Component 3 sample (n=797 flakes). UA2002-62-105, UA2002-62-449, and UA2002-62-878 (Figures 7.43a, 7.43b, and 7.44) are flakes struck from nodules, with minimum diameters of 4 cm. Most of the specimens do not have parallel arrises, suggesting they were not from specially prepared cores. Given the large size of some of the specimens, some may have been brought to the site rather than used from the microblade production debris.

In relation to raw material, two considerations are important: size selection and raw material selection. It is clear that flakes with secondary modification are considerably larger than the vast majority of unmodified flakes in Component 3 (Figure 7.46). This could be the result of either (1) selecting almost all of the larger sized flakes for expedient tool blanks or (2) partial curation of these tools (i.e., bringing them into the site context after manufacture and using and/or discarding them on site). The data would suggest both are possible in Component 3. Ten items (16%) were made of exotic raw material types, defined in terms of relatively low frequencies of debitage, brown chert (C6), yellow jasper (J2), and siltstone (S). These were likely brought into the site and used or discarded onsite. The majority of items were on made on gray chert (C1) and black chert (C4) (n=45, or 74%). Relatively low percentages of modified flakes (0.84 to 2.42%) on material types with high frequencies of microblades suggests that the flakes produced by microblade core reduction were generally not suitable as blanks for use as expedient tools.

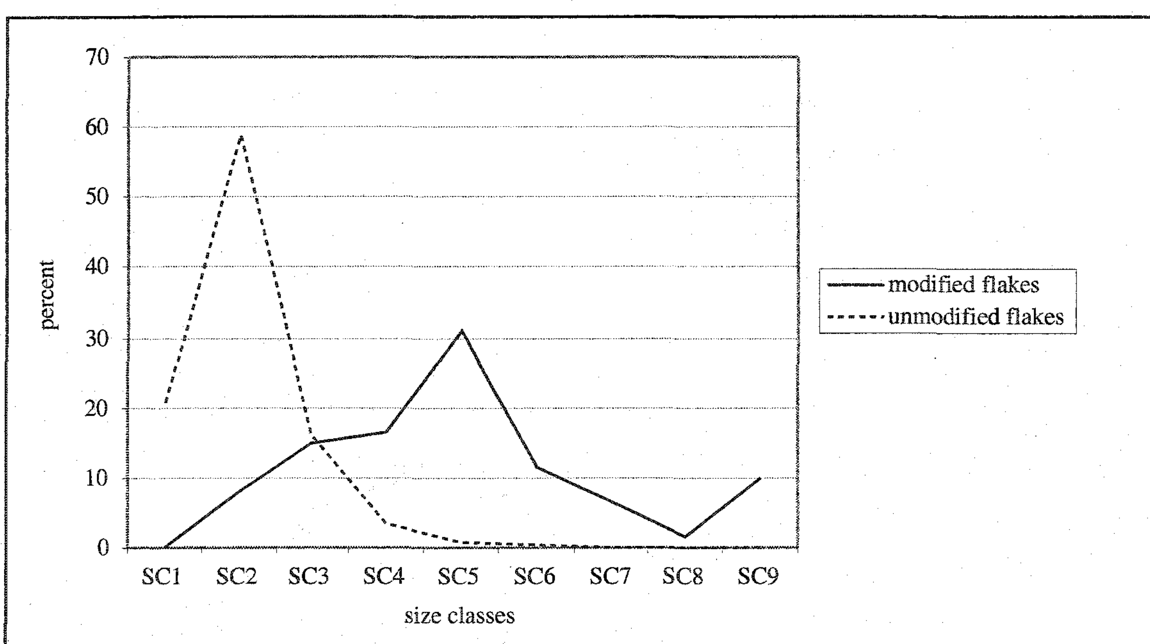


Figure 7.46 Size classes by modified and unmodified flakes.

A comparison of flakes made on exotic and non-exotic raw materials (as defined above) reveals no real difference in maximum dimension and thickness, nor in modification type. This suggests that these expedient tools brought into the site and those produced onsite may have been used for similar tasks.

Spall Scrapers (n=11)

Spall scrapers are manufactured by heavy percussion from water-worn coarse-grained cobbles (see Morlan 1973a:29-32). All Gerstle River specimens have secondary damage/retouch. These items are common in the Alaskan interior and are termed spall scrapers by Cook (1969:197), split cobble tools (Powers 1983:78-79), or boulder chip scrapers (West 1967:370-372). While scraping is implied by the name, these implements were likely used to chop through joints and bone or used in hide scraping, and thus are often associated with butchering and processing activities in later prehistoric sites (Morlan 1973b; Workman 1976; Shinkwin 1979) and recent Athabaskans (Shinkwin 1979:61-62). In his analysis of Healy Lake materials, Cook (1969:96-97) describes two types of spall scrapers, (1) tchi-tho proper, with oval or D-shaped forms with bimarginal flaking on all edges, and (2) cortical flakes with superficial retouch struck from river cobbles. Gerstle River Component 3 spall scrapers are consistent with Cook's second type. None of the spall scrapers found on the site in any component have bimarginal retouch around all edges. However, the retouch is more than superficial, and is characterized as battered, exhibiting evidence use on resilient material, perhaps bone or wood.

A total of eleven spall scrapers were recovered from Component 3 at the Lower Locus, two of which refit (UA2001-71-679 and UA2002-62-245) (Figures 7.47a and 7.47b). In addition, four spall scrapers were found at the Upper Locus within Component 3, one from Test Pit 2 and three from Test Pit 4. All spall scrapers were manufactured from coarse grain river-worn cobbles (primarily quartzite, basalt, and schist), probably derived locally from the outwash plain below the site or from the nearby Gerstle River. Table 7.24 lists metric data on all Lower Locus specimens.

These spalls are cortical flakes with little or no platform preparation prior to a heavy blow detaching these spalls from their cores. Outlines are generally ovate. They have primarily a plano-convex longitudinal cross-section and a convex working edge. No cores or other debris from the manufacturing process were found at any component at Gerstle River. One specimen

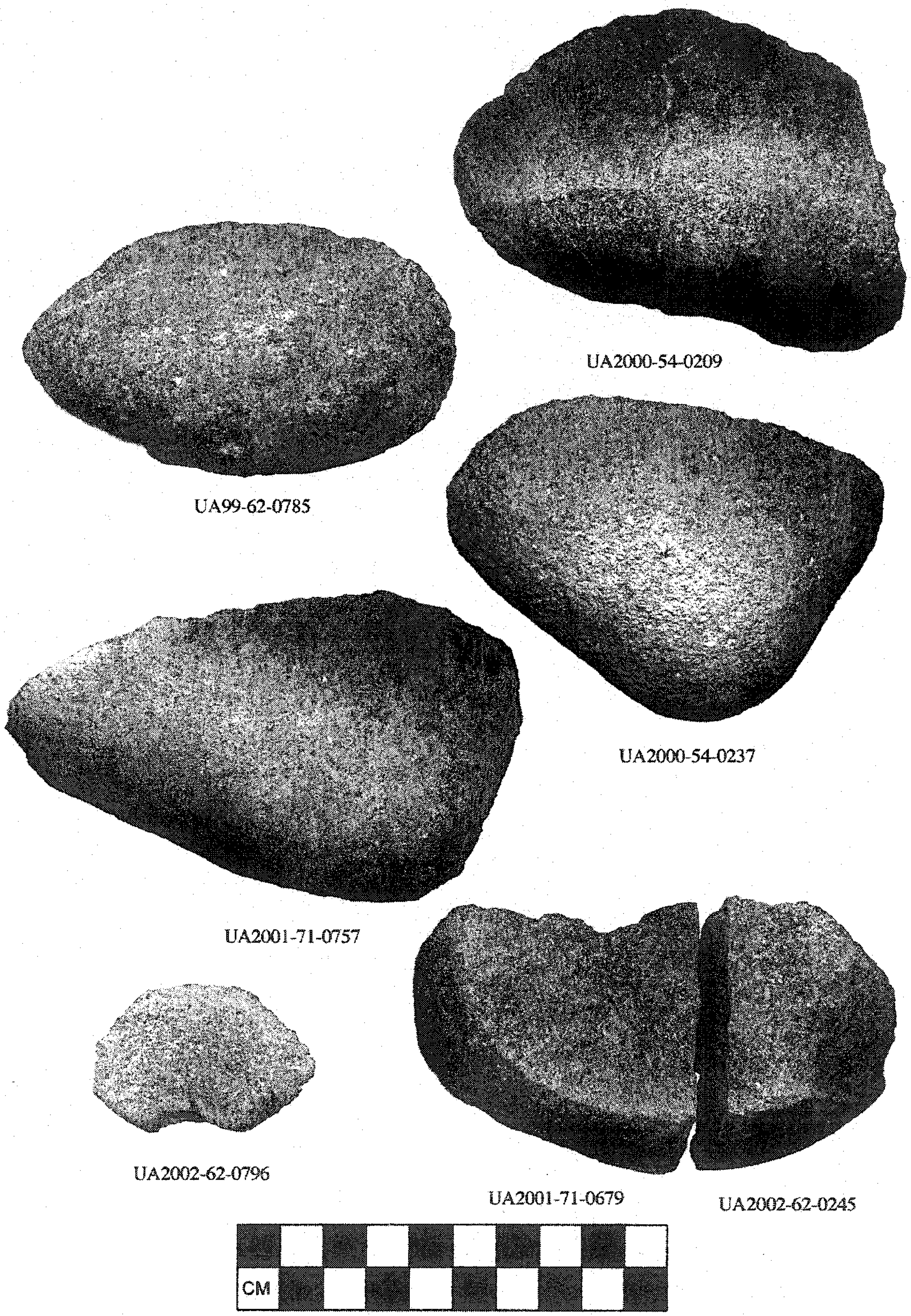


Figure 7.47a Component 3 spall scrapers.

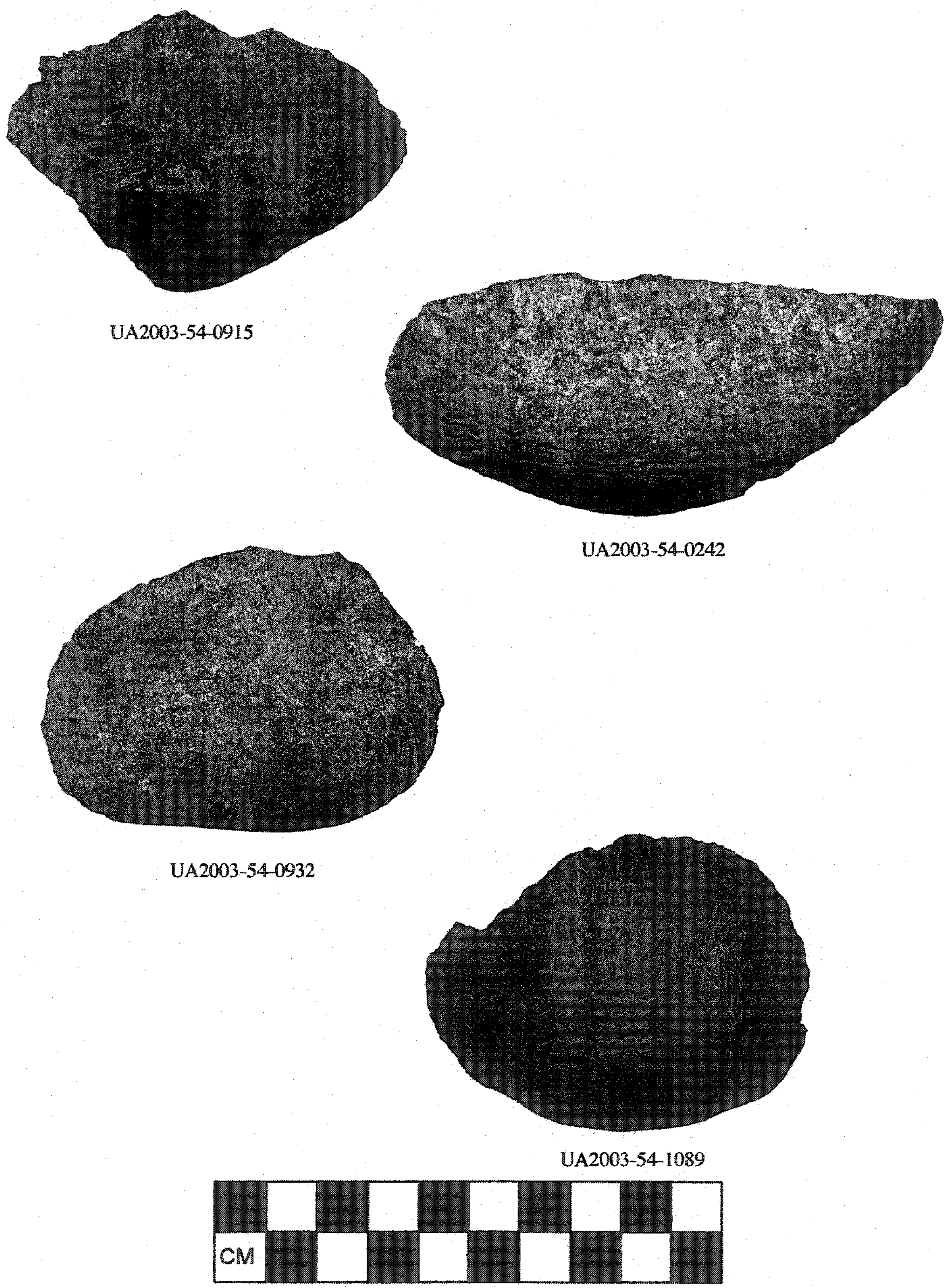


Figure 7.47b Component 3 spall scrapers.

(UA2001-71-679 and UA2002-62-245) does retain a large flake scar (102 mm long) on its dorsal surface (Figure 7.47a). This would suggest that some spall scrapers were produced from split cobble flakes. However, no refitting spall has been recovered to date. It is probable that debris from their manufacture would remain at or near the outwash plain or the nearby Gerstle River. The spalls are typically side-struck flakes (e.g., they are typically wider than long) (see discussion below). No systematic modification of the edges is evident, and they were not shaped through retouch after detachment from the cobble core.

Damage is confined to the margins, and rarely extends more than 5 mm from the edges. Secondary damage/retouch appears primarily on the distal edges of the specimens, though in some cases damage continues to more lateral edges and in rare cases, proximal edges. Retouch is also limited to the margins, and appears on only one specimen, UA2000-54-209 (Figure 7.47a). Two large flakes (23 and 20 mm wide) were removed from the ventral face by direct percussion. Heavy use commonly removes chips from distal edges, and rarely removes flakes from the dorsal surface or chips from the edges. The location of usewear was oriented along the distal edges (in all 11 specimens). Though lateral and proximal usewear was found in 4 specimens, the heavy crushing damage was generally limited to the distal edges. Most of the spalls had utilized edge angles of 20°-30°, with the mode being 20°. Those with higher angles of use were those that had damage/retouch on their proximal edges, which tend to be thicker with larger angles than the distal ends. Given the similarities in location, extent and type of damage, and the utilized edge angles, these tools were probably used in a similar fashion. Heavy chopping, planing, and/or scraping is suggested by the observed patterns of damage. None had evidence of hafting, and the implements were large enough for hand use. None of the spall scrapers were burnt, and all except UA2000-54-237 and UA2003-54-932 had reddish-orange material (possibly ochre) on their utilized edges and ventral surfaces, and more rarely on their dorsal surfaces.

In order to determine if sub-groups existed within the spall scrapers, linear relationships among length, width, weight, damage, and edge angle of use were examined. No sub-groups were apparent based on dimensions or damage characteristics. Spatially, four spall scrapers were within the main area, six within the northeastern area, and one within the southeastern area of Component 3 (see Chapter 10). There appear to be no differences in any attributes by area.

Table 7.24 Component 3 spall scraper attributes (Lower Locus).

Acc.#	*MaxL*	*MaxW*	*MaxT*	*Wt.*	*Usewear*	*edge angle of use**	*NOTES*
UA2000-54-209	75.87	114.07	17.50	175.1	yes	20-30°	
UA2000-54-237	72.76	106.17	22.08	191.1	yes	20°	
UA2001-71-245 UA2001-71-679	64.17	109.60	16.47	123.1	yes	20-40°	Specimens conjoin; large flake removed from dorsal surface
UA2001-71-757	78.44	119.86	16.94	157.7	yes	30°	damage to proximal end in addition to distal wear/damage
UA2002-62-796	32.13	52.01	4.54	8.0	yes	10°	
UA2003-54-242	48.36	115.24	13.46	87.1	yes	20-55°	broken
UA2003-54-915	57.64	80.42	13.36	61.7	yes	-	unable to measure edge angle (undulating ventral surface)
UA2003-54-932	56.26	80.26	8.76	47.2	yes	20°	
UA2003-54-1089	58.90	75.57	17.86	86.9	yes	-	unable to measure edge angle (undulating ventral surface).
UA99-62-785	59.02	103.11	13.06	86.7	yes	25-35°	

* generally ±10 degrees.

Cobble Tools (n=3)

Besides spall scrapers, three other cobble tools were found in Component 3, classified as chopper and two hammerstones based on usewear patterns and morphology (Figure 7.48).

UA2001-71-550, chopper, spall core

This specimen is an angular modified cobble measuring 25.5 cm by 11.9 cm by 9.1 cm and weighing 2.9 kg (Figure 7.48). The material has a coarse grain with macroscopic crystals, though finer grained than the local bedrock. It has a rounded outer surface, estimated 20% cortex remaining, and may have originally been stream-rolled. The specimen appears to have been flaked, with at least 4 large flakes or spalls removed. These flakes would have had similar dimensions and morphology (100% cortex, thickness, edge morphology) to the boulder spalls recovered in this component. Three spalls would have been approximately 9 cm long by 11 cm wide, 10 cm long by 13 cm wide, and 6 cm long by 4 cm wide. None of the boulder spall scrapers recovered at the site refit with the core. Bipolar reduction is evident in the form of crushing on opposite ends of the long axis. Along one edge, wear is evident in the form of crushing damage (small chips removed) confined to less than 1 cm from the edge. This specimen is large and would be bulky to handle. No anvil like battering was evident on the specimen, and its function could have been as a heavy chopper and spall core.

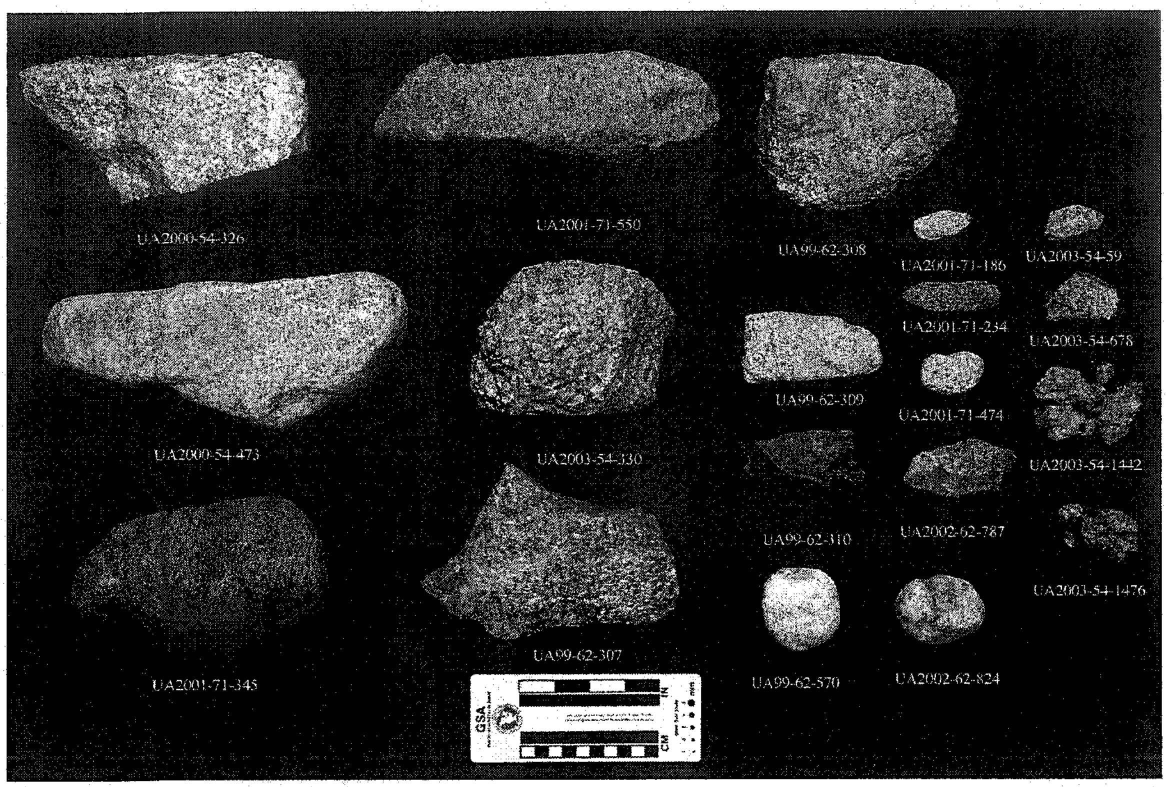


Figure 7.48 Component 3 cobble tools and manuports.

UA99-62-570, hammerstone

This specimen is a rounded river cobble measuring 6.1 cm by 5.6 cm by 4.1 cm and weighing 202.9 g (Figure 7.48). It is thermally altered, reddened and pitted, but extensive battering is not evident. However, the damage caused by the thermal alteration may mask any battering related to use as a hammerstone.

UA2002-62-824, hammerstone

This specimen is a rounded cobble measuring 6.5 cm by 5.1 cm by 3.4 cm and weighing 153.9 g (Figure 7.48). The material is identical to that of UA99-62-570, and is also thermally altered. Battering is evident on the piece, but it may relate to thermal damage.

Cobble tools and manuports (n=17)

Cobbles brought to the site, but which do not have traces of wear are still important in understanding site structure. Given the origin of stratum Y4a (wind transport of silt and very fine sand particles), the presence of cobbles in clear spatial association with Component 3 materials strongly supports their identification as manuports, i.e., brought from off-site and deposited on-site during the Component 3 occupation(s). A total of seventeen cobbles are present within Component 3. These specimens have no macroscopically observable wear, though the generally coarse crystalline structure and hardness (most manuports are granite) makes it possible that these items may have been directly used in processing, especially on relatively soft mammal bone and other tissue. Possible functions include hearthstones, stones used for heating and cooking food, and anvils used for butchering.

The specimens are likely not used as anvils for bipolar reduction of lithic materials as no indications of bipolar reduction was found (such as wedges or bipolar cores) and the resulting battering would be macroscopically visible. Use related to cooking is also not likely given the relative rarity of these specimens and spatial distributions far from hearths. Spatial analysis suggests that the larger cobbles were likely associated with faunal processing (see Chapter 10). Some of the large cobbles may have been used as anvils on which long bones were braced for percussion from another stone (perhaps spall scrapers) in order to crack the bones marrow extraction. Alternately, some may have been used as anvils for joint disarticulation or other butchering activity.

The fact that so few hammerstones were found (n=2) may relate to manufacturing techniques. The lithic analyses (see below and Chapter 8) suggest that tool maintenance and microblade production were the primary tasks at Gerstle River, and pressure flaking implements (using billets, etc.) may have played a larger role than direct percussion. Hammerstones are also generally lacking at Dry Creek, Component 2. They are not associated with microblade clusters at that component (Clusters A, B, C, G, N), but present in small numbers in clusters dominated by biface production and large flake sizes (Clusters L, etc.) (see Hoffecker 1983a, b).

UA99-62-307, hearthstone-manuport, possible anvil

This specimen is an angular granite cobble measuring 18.5 cm by 10.9 cm by 7.1 cm and weighing 1496.9 g (Figure 7.48). The lower surface is thermally altered and reddened. Any of the flat surfaces may have been used as an anvil or brace, and one edge may have been used as a heavy chopper, but interpretation of damage as possible usewear cannot be supported by macroscopic examination.

UA99-62-308, hearthstone-manuport, possible anvil

This specimen is an angular granite cobble measuring 13.9 cm by 11.6 cm by 5.6 cm and weighing 1451.4 g (Figure 7.48). The lower surface is thermally altered and reddened. A flat area is present on the upper surface, perhaps with battering damage. The coarse nature of the material makes it difficult to discern usewear. One edge could have been used as a heavy chopper.

UA99-62-309, hearthstone-manuport (possible hammerstone)

This specimen is a rounded schist cobble measuring 10.4 cm by 5.2 cm by 3.1 cm and weighing 248.9 g (Figure 7.48). This specimen may have been used as a hammerstone, but extensive battering is not evident.

UA99-62-310, hearthstone-manuport

This specimen is an angular granite cobble measuring 8.5 cm by 5.7 cm by 4.3 cm and weighing 362.9 g (Figure 7.48). The specimen exhibits extensive thermal alteration, but no usewear was observed.

UA2000-54-326, hearthstone-manuport (possible anvil)

This specimen is an angular cobble of local bedrock measuring 22.0 cm by 13.5 cm by 8.9 cm and weighing 2.4 kg (Figure 7.48). This specimen would not be suitable for use as an anvil and is easily fractured. The bottom has been thermally altered and displays a reddened appearance and is more heavily pitted than other areas of the rock. There are no visible striations or other evidence of wear by an abrasive object, and the edges do not appear to have been modified. The orientation when found does provide a flat surface of approximately 13 by 10 cm, and use with soft materials cannot be excluded, though no polish was evident under 10x magnification.

UA2000-54-473, manuport (possible anvil)

This specimen is a rounded cobble measuring 27.0 cm by 10.7 cm by 6.3 cm and weighing 3.2 kg (Figure 7.48). This specimen has a reddish staining on the bottom surface. Though similar in dimension and form to anvils found at Dry Creek, component 2, no heavy grinding or crushing damage was apparent and no spalls were removed. The relative lack of bipolar technology, the nature of the component 3 primary technology, and the lack of associated lithic debris would suggest that this was not used in lithic production. However, this could have been used in processing game, perhaps as an anvil.

UA2001-71-186, UA2001-71-234, UA2001-71-474, manuports, hearthstone

These three specimens are schist small cobbles/large pebbles between 4.4 and 7.9 cm in maximum dimension and 0.7 and 1.1 cm in minimum dimension, weighing 7.1-23.5 g (Figure 7.48). All three are exfoliating with small lamellar pieces flaking off since recovery. UA2001-

71-474 is flat on one side, suggesting it may have been split. No usewear is evident on any of the pieces. UA2001-71-234 was found associated with Feature 5.

UA2001-71-345, manuport

This specimen is a rounded cobble measuring 18.5 cm by 10.3 cm by 9.7 cm and weighing 3.1 kg (Figure 7.48). It has exfoliated small spalls during and after excavation. Thermal alteration is evident in the presence of pits. An ochre-like substance is found in one of the cracks of the cobble surface. This specimen is too heavy and bulky to function as a hammerstone, and no evidence of modification is present.

UA2003-54-330, hearthstone – manuport, possible anvil

This specimen is an angular granite cobble measuring 15.6 cm by 10.9 cm by 8.8 cm and weighing 3.4 kg (Figure 7.48). The cobble was found directly within hearth Feature 16, and the lower surface is thermally altered and reddened. Any of the flat surfaces may have been used as an anvil, but damage cannot be discerned macroscopically.

UA2002-62-787, UA2003-54-59, UA2003-54-678, UA2003-54-1442, UA2003-54-1476 manuports, hearthstone

These five specimens are angular granite cobbles between 3.8 and 8.8 cm in maximum dimension and 2.6-3.2 cm in minimum dimension and weighing between 40.2 and 223.1 g (Figure 7.48). The latter two specimens are crumbling into smaller fragments about 3 mm in size after recovery. UA2003-54-59 was particularly fine-grained granite, and it was possibly tested. No usewear was observed on any of these specimens, and UA2003-54-678 was located in Feature 16.

Unmodified flakes (n=5,591)

A total of 5,591 unmodified flakes, flake fragments, and shatter (angular debris) were recovered from Component 3, weighing 297.00 g (averaging 0.053 g/flake). Detailed debitage analysis is presented in Chapter 8. Table 7.25 lists number of flakes by material type. Almost half of the flakes were gray chert (C1) and about 10% were black chert (C4), white rhyolite (R2), and light gray-black banded chert (C2). The remaining 14 material types made up between 0.02 and 4% of the flake assemblage.

Table 7.25 Component 3 flake totals by material type.

Mat.	N	%	Wt (g)	%
C1	2657	47.52	138.36	46.59
C4	747	13.36	31.43	10.58
R2	633	11.32	41.07	13.83
C2	554	9.91	24.97	8.41
Ar	237	4.24	12.83	4.32
R1	234	4.19	10.30	3.47
Ch3	138	2.47	5.00	1.68
C7	121	2.16	6.55	2.21
An	111	1.99	9.51	3.20
C9	85	1.52	4.49	1.51
O	38	0.68	2.35	0.79
Ch2	16	0.29	0.52	0.18
D	8	0.14	1.17	0.39
B	4	0.07	3.53	1.19
C8	3	0.05	4.06	1.37
S	3	0.05	0.80	0.27
C3	1	0.02	0.03	0.01
J1	1	0.02	0.03	0.01
TOTAL	5591	100.00	297.00	100.00

Miscellaneous Items

A number of other items were found in Component 3, including ten red ochre fragments. These pieces were very small (<5 mm in diameter), and found in EU N53E48-49 associated with faunal remains and lithics in and near Feature 18.

An interesting find was a fossil brachiopod (UA99-62-76) found in EU N48E42 near Feature 1 (Figure 7.49). The identification to the Phylum Brachiopoda has been confirmed by Dr. Sarah Fowler, paleontologist at UAF. The hinge area is missing, so more specific identification is probably not possible. The location of this fossil within an activity area (Subarea B1, see Chapter 10) suggests that it was brought there and discarded by an occupant of the site.

Component 4 Artifacts (~8700 BP, ~9700 cal BP)

Component 4 artifacts include 43 individual lithic artifacts. Of these, 10 (23.3% of total items) are secondarily modified in some way, with 1 formal tool and 9 expedient tools (see Figures 7.50 through 7.51). Artifacts by category include 1 burin, 9 modified flakes, 1 microblade, and 32 unmodified flaking debris.

Figure 7.49 Component 3 brachiopod fossil.

Burin (n=1)

UA2002-62-741 burin

This specimen is classified as a Donnelly burin, made on a thick flake of brown chert (C6) measuring 25.4 mm long, 21.8 mm wide, 7.5 mm thick, weighing 4.2 g (Figure 7.50). The platform of the original flake blank has been removed through burination. Unifacial usewear consisting of microflaking extend along the right lateral edge extending 5 mm on the dorsal face. The edge angle of this retouch is 45°. The microflaking is delicate on the distal end, but numerous hinge fractures are evident on the proximal end forming a notch and platform for the removal of a burin spall. The burin spall was removed transverse across the proximal end from the right lateral edge, and the negative bulb of force is still evident. The burin facet measures 3.9 mm at maximum width and 13.5 mm long, terminating midway across the proximal end. Light burin wear is evident along most of the proximal-ventral edge. One or more burin facets removed the left lateral edge of the flake from proximal to distal, but the proximal ends are not present due to damage and possible retouch at the left-proximal edge of the flake. This burin facet measures

6.3 mm at maximum width and is 26.0 mm long. Light burin wear is evident on the left lateral-ventral edge near the distal end. The working edge formed by the proximal burin facet and ventral surface is 100°, and the working edge formed by the left lateral burin facet and ventral surface is 90°.

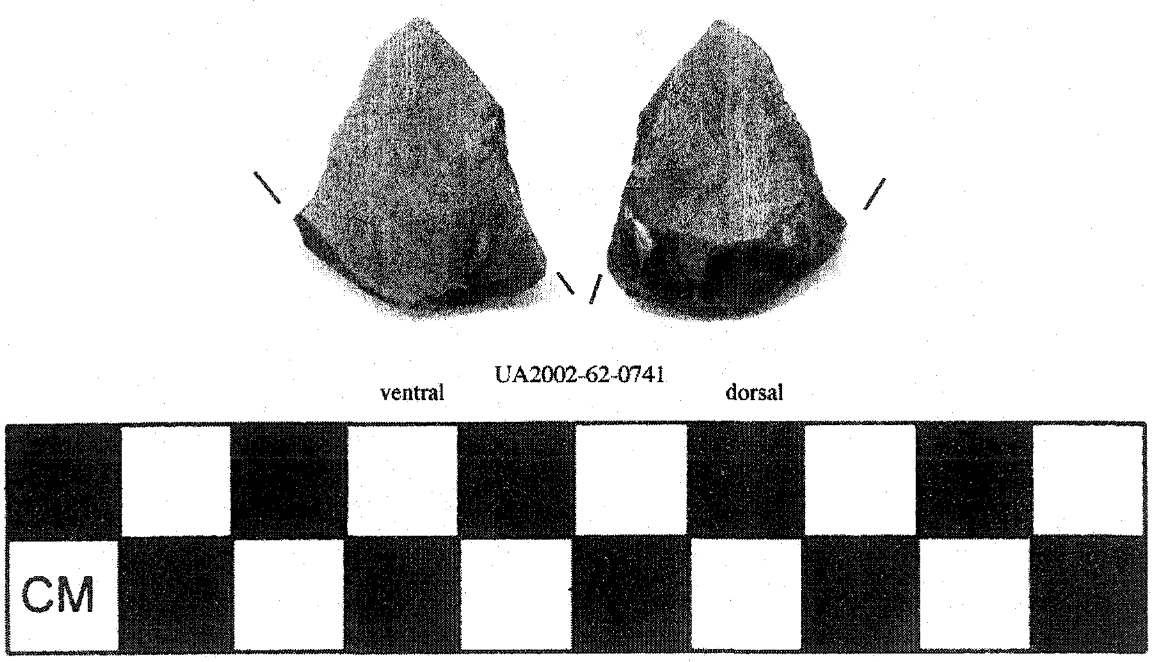


Figure 7.50 Component 4 burin.

Modified flakes (n=9)

The group of modified flakes from Component 4 within Block Y show similarities in morphology, size, and technological characteristics (Figure 7.51). They are generally large compared to unmodified flakes, ranging from 16.6 mm to 28.2 mm in maximum dimension and weighing from 0.4 to 1.3 g (average = 0.9 g). They were manufactured through percussion, and complete and proximal fragments display salient bulbs of force and in some cases have lips. Eraillure scars are present on some specimens. All are manufactured from black chert (C4). Damage is relatively consistent, and is primarily moderate to heavy edge damage on two to three edges, rarely extending beyond 1 mm on the dorsal or ventral surfaces. Edge angles are generally low, between 10° and 30°, and the damage suggests slicing or cutting of soft materials. Edge

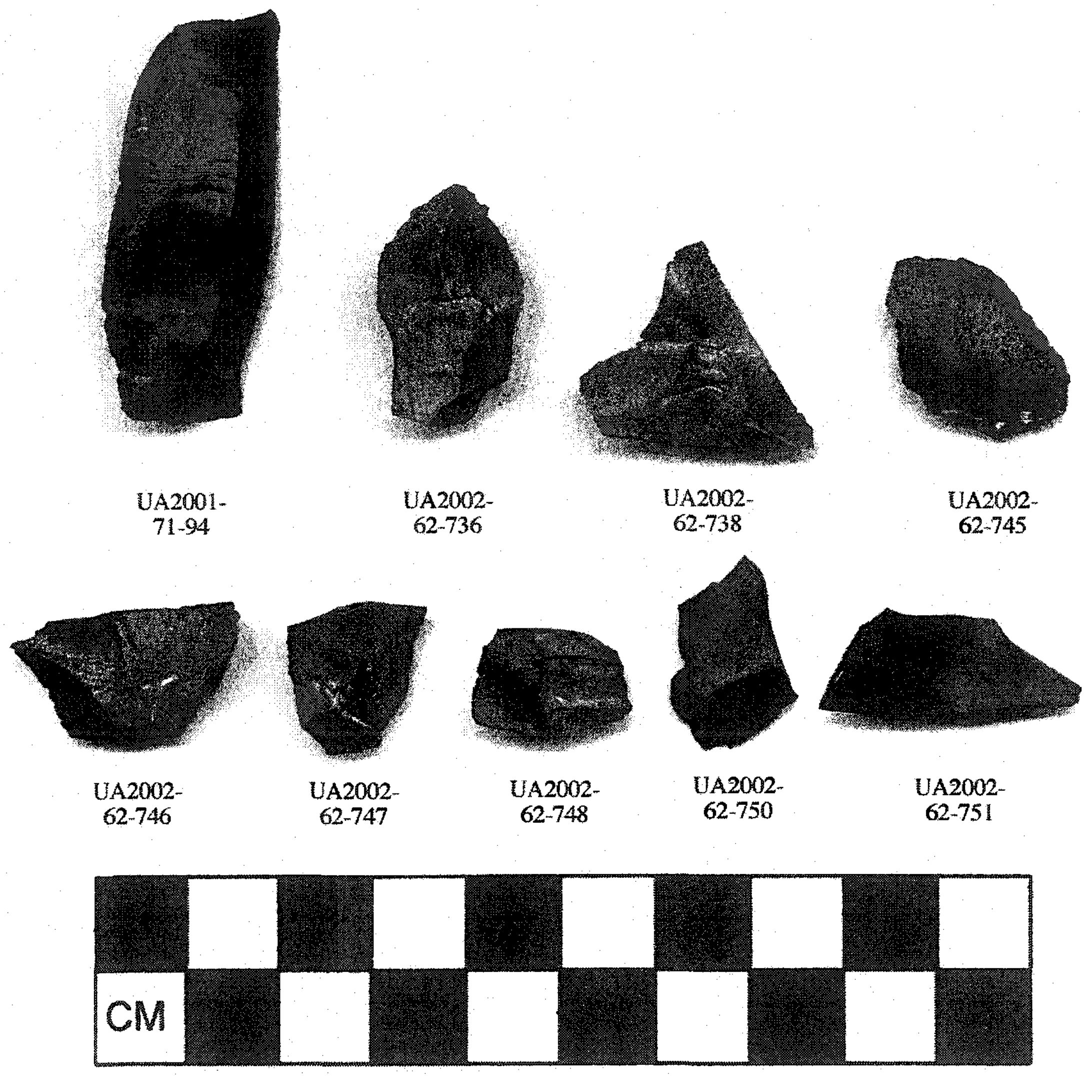


Figure 7.51 Component 4 modified flakes.

shapes are generally straight, but two of the specimens (UA2002-62-736 and UA2002-62-745) are characterized as notches. UA2002-62-751 also exhibits burin wear for 8 mm along the distal end, with an edge angle of 80°.

One modified blade was recovered in Component 4 near Feature 7.

UA2001-71-94, modified blade

This specimen is a modified blade of black chert (C4) measuring 46.3 mm long, 17.6 mm wide, 6.2 mm thick, and weighing 4.8 g (Figure 7.51). Light edge damage is present on the right and left lateral and distal margins. Edge angles are between 15° and 40°. Modification length is

43.9 mm for the right lateral edge, 42.0 mm for the left lateral edge, and 11.6 mm for the distal edge. Damage is characterized as light.

Microblade (n=1)

A single unmodified microblade distal fragment of black chert (C4) was recovered from Component 4 in the eastern area (Area H, see Chapter 10).

Unmodified flakes (n=32)

A total of 32 unmodified flakes, flake fragments, and shatter (angular debris) were recovered from Component 3, weighing 1.90 g (averaging 0.06 g/flake). All of the flakes were of black chert (C4). Detailed debitage analysis is presented in Chapter 8.

Component 5 Artifacts (~8000 BP, ~8900 cal BP)

Component 4 artifacts include 87 individual lithic artifacts. None of the items are secondarily modified. Artifacts by category include 1 manuport cobble and 86 unmodified flaking debris.

Cobble manuport (n=1)

UA2003-54-93, manuport, possible chopper

This specimen is a subrounded cobble measuring 13.9 cm by 11.2 cm by 3.3 cm and weighing 794 g. It is a tabular slab, similar in dimension to boulder spall scrapers found at the site, but the material is exfoliating in layers. One edge may be damaged, but it is difficult to discern giving the material and exfoliation. This edge is relatively sharp, with an edge angle of about 70°. There is no thermal alteration present on this specimen.

Unmodified flakes (n=86)

A total of 86 unmodified flakes, flake fragments, and shatter (angular debris) were recovered from Component 4, weighing 2.78 g (averaging 0.03 g/flake). Detailed debitage analysis is presented in Chapter 8. Table 7.26 lists number of flakes by material type. White rhyolite (R2), argillite (Ar), and obsidian (O) are almost equally represented (21-45%).

Table 7.26 Component 5 flake totals by material type.

Mat.	*N*	*%*	*Wt (g)*	*%*
R2	39	45.35	1.25	44.96
Ar	27	31.40	0.81	29.14
O	18	20.93	0.66	23.74
Ch2	2	2.33	0.06	2.16
TOTAL	86	100.00	2.78	100.00

Artifacts from Disturbed Contexts

Artifacts from disturbed contexts (e.g., surface or overburden) include 235 individual lithic artifacts. Of these, 38 (16.2% of total items) are secondarily modified in some way, with 19 formal tools and 19 expedient tools (see Figures 7.52 through 7.57). Artifacts by category include 1 microblade core, 8 modified microblades, 2 burins, 1 burin spall, 4 unifaces, 4 bifaces, 6 modified flakes, 8 spall scrapers, 5 hammerstones, 25 unmodified microblades, and 171 unmodified flaking debris. These materials may be from any of the components, but most are probably related to Component 3 for a number of reasons. First, the other components are dominated by specific material types that are rarely found in the disturbed collection. The Component 1 assemblage is composed primarily of green chert (86%), quartz, quartzite, and andesite. The Component 2 assemblage is dominated by chalcedony (76% in Area E) and quartzite (97% in Area F). Components 4 and 5 are relatively small and have a limited number of tools. However, Component 3 is by far the largest assemblage at the Lower Locus (70% of all lithic items), containing 20 raw material types (vs. 2-7 for the other components). Most of the other assemblages are located in small, discrete concentrations, whereas Component 3 is spread out over a large area, including several at the eroding bluff edge. Finally, many of the disturbed materials resemble Component 3 specimens, including unifaces, burins, and burin spalls.

Microblade core (n=1)

20032-62-9, microblade core

This specimen is classed as a tabular microblade core of gray chert (C1), weighing 2.9 g (Figure 7.52). The general morphology suggests an intermediate form between a classic "tabular core" and a subconical core, similar to UA2002-62-325, described above. This piece was manufactured from a flake or nodule of chert, with the entire back consists of an unmodified flat surface with weathered patina. Core height is 24.9 mm, core width (side to side) is 15.9 mm, and core length (front to back) is 8.2 mm. The platform is semi-circular, with the fluting arc opposed by the flat unretouched back element. The platform measures 15.9 mm from side to side and 7.5 mm from front to back, with a platform angle of 60°. While no negative bulbs are present to indicate removal direction of core tablets, flake scars do suggest an outrepasse detachment was made from the right side that removed some of the back element of the core. Microblades were apparently not struck from the present platform, evidenced by the absence of negative bulbs on the proximal fluting surface. The microblade flutes extend from the platform to the bottom of the core. The longest microblade flute length is 23.8 mm. Five flutes are present, with an additional truncated sixth with a feather termination on the far right and a truncated seventh with a hinge termination on the far left edge of the fluting face. Flute width ranges from 2.86 to 4.94, with a mean of 4.09±0.89 mm. The base of the core on the fluting face exhibits microflaking extending less than 1.5 mm, but no damage is apparent on the back. The core is quite small relative to complete microblades, and it is likely exhausted.

Microblades (n=33) and burin spall (n=1)

Thirty-three microblades and one burin spall were recovered from disturbed contexts. Eight of the microblades were modified, two end modified, two burinated along one lateral edge, two with lateral damage, one with lateral retouch on both edges, and one with dorsal damage (Figure 7.53). Microblade were made of C1 (n=20), C4 (n=4), R1 (n=4), Ch1 (n=2), Ar, C7, and O (n=1 each). This suggests that most of the microblades were originally from Component 3, though the Ch1 microblades likely were from Component 2, suggesting another Component 2 activity area may have been located south of the current bluff edge. Average proximal width is

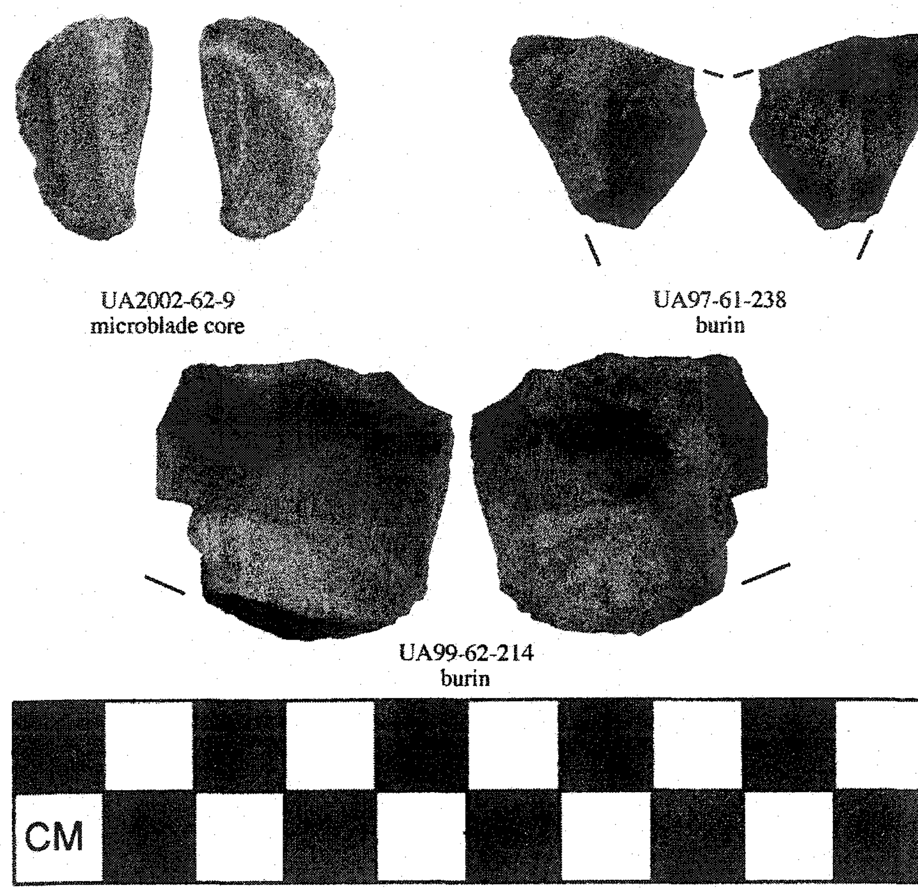


Figure 7.52 Microblade core and burins from disturbed contexts.

6.6±1.5 mm, more similar to Component 3 than Component 2 (5.9±1.6 mm vs. 4.9±1.4 mm respectively).

A single burin spall is an undamaged secondary burin spall of gray chert (C1) measuring 22.0 mm long, 1.9 mm wide, and 3.3 mm thick (Figure 7.53).

Burins (n=2)

UA99-62-214, burin

This specimen is manufactured from a thick flake of very fine grain gray chert (C1). Maximum dimensions are 30.5 x 33.0 x 8.8 mm, with a weight of 9.5g (Figure 7.52). This specimen may have been a short-axis beveled flake due to the presence of retouch and usewear on the short axis (proximal end) of the flake. However, the removal of most of the worked edge by a

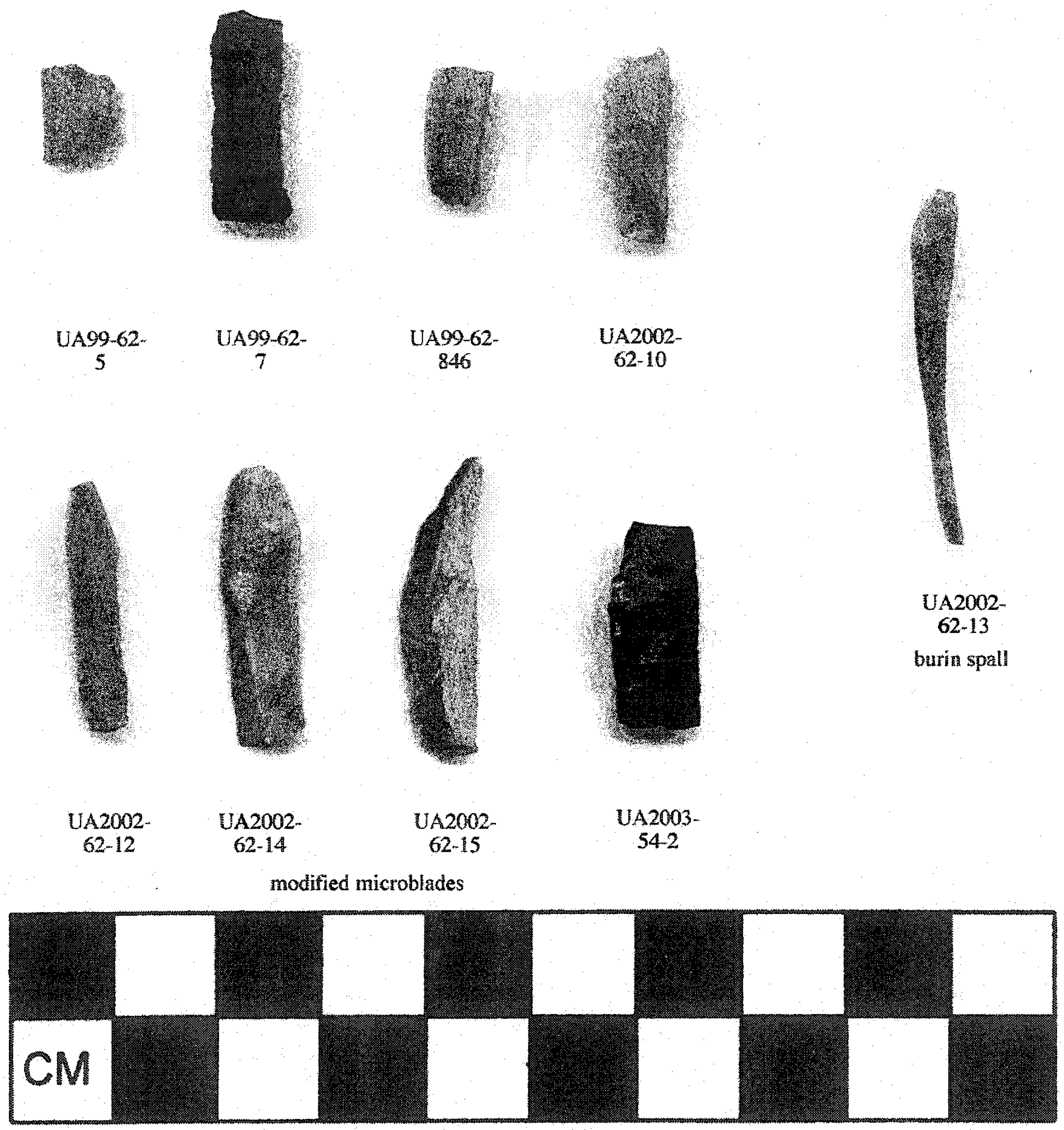


Figure 7.53 Microblades and burin spall from disturbed contexts.

burin blow obfuscates the earlier form of the specimen. One area of the original working edge remains below the termination of the burin scar. Using this retouched remnant as a guide, the specimen presently (and probably originally) has a slightly convex working edge shape, with unifacial retouch and damage extending 28.8 mm across the working edge, with an edge diameter of 25.3 mm. The cross-section of the specimen at its working edge is biconvex, though is difficult to estimate the original cross-section. The thickness at its working edge is 6.7 mm. The specimen is burinated transverse to its longitudinal axis across the worked edge. The burin scar (up to 5.5 mm wide) was struck from the right proximal corner, and extends across nearly the entire face. No edge angle could be determined for the beveled flake use, but the angle produced by the burin was 120°, clearly more obtuse than most short-axis beveled flakes.

Typical end scraper retouch was evident in the form of microflake scars and crushing damage on the remaining working edge area of the short-axis beveled flake. Flaking and crushing evident on the edge just lateral to the negative bulb of force from the burin spall is likely related to burin platform preparation. The burin scar proximal edge and ventral edge were utilized after the burin blow had been struck, evident in the form of damage at the burin tip and six small 1-2 mm wide hinged flake scars with step terminations on the ventral side respectively. No polish is evident on the dorsal arrises.

UA97-61-238, burin

This specimen is manufactured from a thin flake of black chert (C4), measuring 21.3 mm long, 23.6 mm wide, 5.3 mm thick, weighing 2.6 g (Figure 7.52). The platform of the original flake blank was abraded. Two burin facets are present, one initiated near the platform, removing the left lateral edge of the flake, and another initiated from a platform prepared through unifacial flaking of a notch at the right distal end and removing the distal end of the flake, terminating at the left distal end. The left lateral burin facet measures 16.9 mm long and 5.2 mm wide. The distal burin facet measures 20.9 mm long and 3.4 mm wide. Major burin damage is present on the left lateral facet on the dorsal edge with numerous hinge fractures up to 5 mm on the dorsal face. Polish is evident on the same edge along the distal 6 mm of the burin facet. Minor burin damage is present on the distal facet on the ventral-distal edge extending 0.4 mm on the burin facet. Working edge angle is 80° for the left lateral burin facet and 100° for the distal burin facet.

Unifaces (n=4)

Four unifaces were recovered from disturbed contexts, two classified as short-axis beveled flakes (UA99-62-44 and UA2002-62-1) and two classified as long axis beveled flakes (UA2001-71-21 and UA2001-71-49) (Figure 7.54).

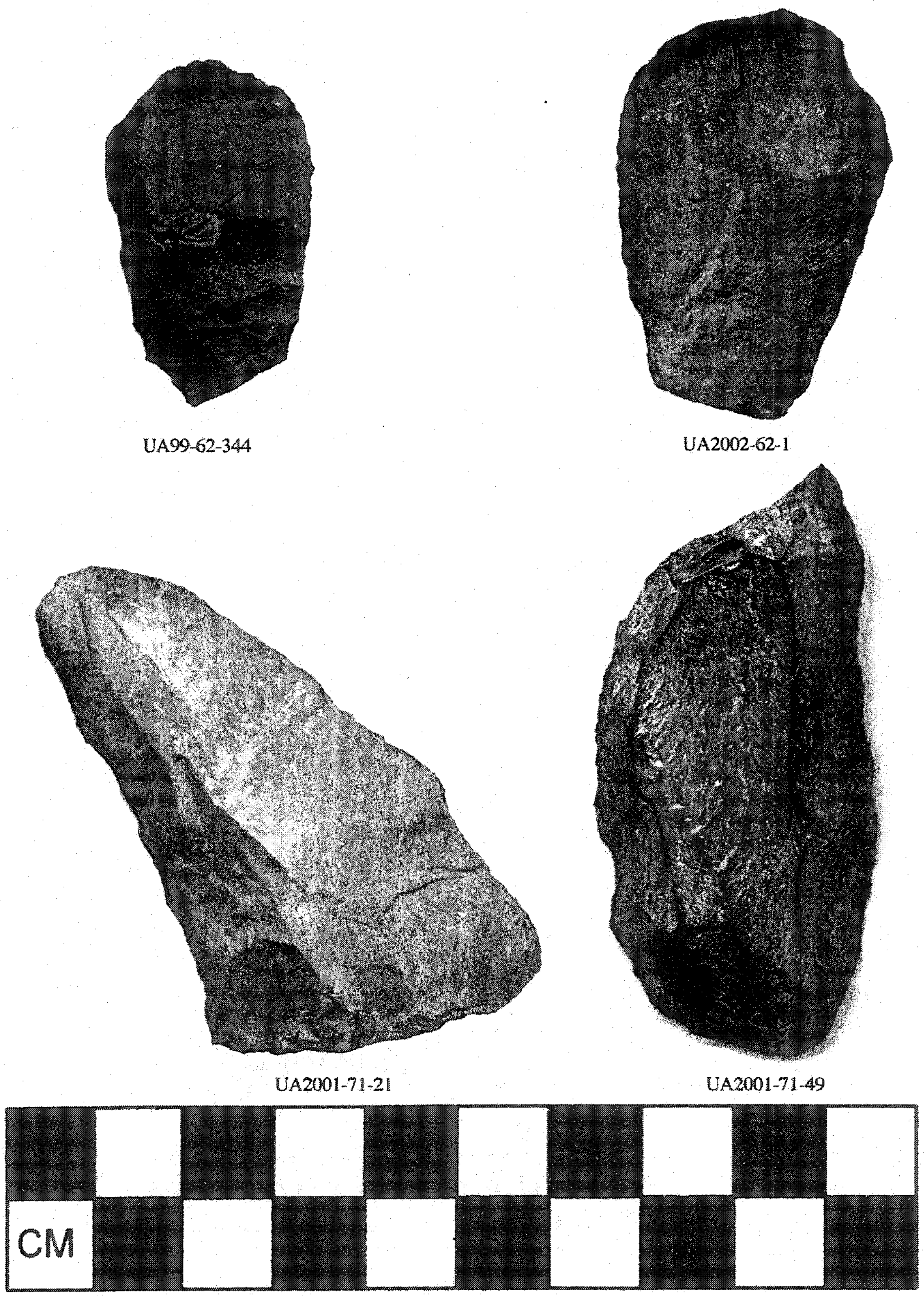


Figure 7.54 Unifaces from disturbed contexts.

UA99-62-44, short-axis beveled flake

One short-axis beveled flake was recovered from Component 7, UA99-62-44 (Figure 7.54). This specimen is manufactured from a thick flake of dark red chert or rhyolite (C8). Maximum dimensions are 38.3 x 29.2 x 11.5 mm, with a weight of 11.5g. The cross section is plano-convex at the working end, and the specimen is unifacially retouched all around the margin except for the prominent platform (retaining a pronounced lip on its ventral edge). Platform preparation appears in the form of numerous hinge fractures just below the platform. The short-axis beveled flake has a convex working edge shape, with unifacial retouch and damage extending for 40.1 mm along the distal end of the flake to the left lateral edge extending almost to the platform edge, with an edge diameter of 27.5 mm. The thickness of the specimen at its working edge is also its maximum thickness, 10.3 mm, and the angle of utilization is 60°. Damage is in the form of microflake scars, hinge fractures, and crushing at the working edge. In size and morphology (though not wear damage), this short-axis beveled flake is similar to UA2003-54-1062 from Component 3, and UA2002-62-1 from disturbed contexts.

UA2002-62-1, short-axis beveled flake

This specimen is manufactured from a thick flake of dark red chert or rhyolite (C8) (Figure 7.54). Maximum dimensions are 45.7 x 30.6 x 10.0 mm, with a weight of 16.0g. Though the platform is not present, the thickest point is located on one side at midpoint on the specimen. This, along with a pronounced bulb on the ventral surface at this point, suggests that the original platform was on the lateral edge (relative to the working edge) of the flake. The cross section is plano-convex at the working end, and the specimen is exhibits unifacial retouch and crushing along most of its lateral circumference. The short-axis beveled flake has a convex working end shape, with unifacial retouch and damage extending almost all the way around the flake's circumference (49.8 mm), with an edge diameter of 26.4 mm. The thickness of the specimen at its working edge is 5.5 mm, and the angle of utilization is 60°. Damage is in the form of microflake scars, hinge fractures, and crushing at the working edge. In size and morphology, this short-axis beveled flake is similar to UA2003-54-1062 from Component 3 and UA99-62-44 from Component 7.

UA2001-71-21, long axis beveled flake

This specimen is classed as a long axis beveled flake, or double side scraper, and is manufactured form a large blade-like flake of gray chert (C6) (Figure 7.54). The platform is still present, and does not exhibit platform preparation indications. Maximum dimensions are 68.5 x 38.0 x 9.5 mm, with a weight of 21.1g. The specimen exhibits unifacial retouch on both lateral edges, 36.2 mm on the right edge that includes some of the distal end and 53.0 mm on the left edge Both working edges are relatively straight, with edge thickness of about 6.9 mm for each edge. Angles of utilization are similar for both edges, 55° for the left and 60° for the right, though the edge angle measurements are about 30° if including the contour of the dorsal surface. Damage consists of microflaking and minor hinge fracture scars, rarely extending for more than 3 mm from the edge. This specimen is very similar to another double side scraper found in Component 3 and made of the same material (UA2000-54-73).

UA2001-71-49, long axis beveled flake

This specimen is classed as a long axis beveled flake or double side scraper and is manufactured from a thick blade-like flake of dark red chert or rhyolite (C8) (Figure 7.54). Maximum dimensions are 65.3 x 31.0 x 12.4, with a weight of 26.6g. The specimen exhibits unifacial dorsal retouch on both lateral edges, 67.0 mm on the right and 63.8 mm on the left. Two flakes (about 10 mm wide) were removed from the left ventral side. The right working edge is straight and the left is slightly convex, with working edges thickness of 6.8 mm. The right lateral edge is relatively flat and the left lateral edge undulates slightly, due to the removal of two flakes ventrally. Angles of utilization are the same for each edge, at 60°. Damage consists of microflaking and crushing, rarely extending more than 4 mm from the edge. The distal tip is broken, and there are a number of adjacent step fractures on the dorsal surface. This specimen may have been burinated, but no negative bulb is present and no damage was observed on the edges. Polish is evident on the dorsal arrises, suggesting that this piece was hafted.

Bifaces (n=4)

Two bifaces and two biface fragments were recovered from disturbed contexts (Figure 7.55).

Figure 7.55 Bifaces from disturbed contexts.

UA97-61-171 bimarginally retouched flake

This specimen is a complete bimarginally retouched flake of dark red chert or rhyolite (C8), measuring 95.0 mm long, 55.5 mm wide, 12.2 mm thick, and weighing 79.1 g (Figure 7.55). The outline is sub-ovate with unifacial retouch on the left dorsal face, the right-distal ventral face, and usewear retouch on the distal end. The cross section is bi-beveled due to this retouch. The specimen is not symmetrical in outline or in cross-section. The edge angles are 40° on the left and right lateral edges. The flaking orientation is random and extends 12.5 mm from the left lateral/dorsal edge and 13.1 mm from the right lateral/ventral edge. Flake scar outlines are expanding and are up to 27 mm wide. The platform of the original blank is still present, and the distal end, terminating in a hinge fracture has not been removed by retouch. Microflaking, polish, and numerous hinge scars are present on both working edges, with more hinge fractures on the right/ventral edge. This implement was likely not hafted given the size and orientation of the working edges. The usewear suggests use of this implement was in a unidirectional manner (similar to a scraper) as very little damage was apparent on the edges of the faces opposite the working edges.

UA97-61-184 biface

This specimen is a complete biface of dark red chert or rhyolite (C8), measuring 73.6 mm long, 39.6 mm wide, 13.1 mm thick, and weighing 47.1 g (Figure 7.55). The outline is lanceolate with the lateral edges forming shoulders 36 mm and 39 mm from the base. The cross section is biconvex to plano-convex. The specimen is not symmetrical in outline or in cross-section. The edge angles are 35° on the right lateral edge and 50° on the left lateral edge. The flaking orientation is random and extends across both faces. Most flake scar outlines are expanding and some are parallel, ranging from 5 to 15 mm across, and most are over 10 mm across. Microflaking, numerous hinge scars, heavy polish, and rounding was present on both lateral edges (on both faces) and the tip suggesting heavy use as a knife (i.e., bidirectional motion such as cutting or sawing). Polish is present on the arrises on both faces, suggesting hafting wear. The biface is quite thick for its length, and there is no evidence of flaking for the purpose of thinning the biface further.

UA99-62-128 biface fragment

This specimen is a small bifacially worked fragment of gray chert (C1), measuring 7.8 mm long, 22.8 mm wide, 5.1 mm thick, and weighing 0.8 g (Figure 7.55). The fragment is too small to support detailed interpretation. The fragment appears to be a midsection. The one bifacial edge exhibits a plano-convex cross section, with flake scars that extend only 1.6 mm or less on the flat face. On the opposite end from the bifacial edge, the fragment comes to a point that exhibits microflaking, suggesting possible use after breakage. There is usewear damage on the bifacial edge suggesting that the biface broke during use rather than during manufacture.

UA2001-71-81 projectile point base

This specimen is a biface base of gray chert (C1), measuring 18.1 mm long, 23.8 mm wide, 6.7 mm thick, and weighing 3.0 g (Figure 7.55). The outline suggests the complete biface was a lanceolate form with a pointed base, with about 5 mm of the basal portion broken. The cross-section is lenticular. The specimen is symmetrical in outline and in cross-section. The edge angles are 45-50°. The flaking orientation is parallel-oblique and the specimen is considered finely flaked. Flake scar outlines are parallel and measure 3-5 mm. The specimen exhibits edge grinding on all extant edges. Based on thickness, symmetry, breakage, and edge damage, this specimen probably was a projectile point that broke in the haft, and was subsequently removed and discarded on site.

Modified flakes (n=6)

Six modified flakes were found in disturbed contexts (Figure 7.56). These specimens fall within the variability exhibited by Component 3 modified flakes (see above).

UA99-62-54, modified flake

This specimen is a complete flake of siltstone measuring 25.3 mm long, 30.8 mm wide, and 6.8 mm thick, and weighing 4.4 g (Figure 7.56). Edge damage is present for 31 mm on the distal edge, with an edge angle of 20°.

UA2001-71-56, modified flake

This specimen is a distal flake fragment of black chert (C4) measuring 37.9 mm long, 25.8 mm wide, 11.1 mm thick, and weighing 9.4 g (Figure 7.56). Light edge damage and microflaking was evident on both distal-lateral corner edges, with working edge angles between 30° and 40°.

UA2003-54-49a, modified flake

This specimen is a medial flake fragment of gray chert (C1) measuring 11.5 mm long, 20.3 mm wide, 1.9 mm thick, and weighing 0.6 g (Figure 7.56). Microflaking and edge wear is present on the left lateral edge (with 10° edge angle) and distal edge (with 85° edge angle).

UA2003-54-49b, modified flake

This specimen is a distal flake fragment of gray chert (C1) measuring 8.5 mm long, 15.5 mm wide, 2.6 mm thick, and weighing 0.2 g (Figure 7.56). Microflaking is evident on the distal-dorsal edge, with an edge angle of 10°.

Figure 7.56 Modified flakes from disturbed contexts.

UA99-62-32, modified flake

This specimen is a medial flake fragment of dacite measuring 51.7 mm long, 36.7 mm wide, 8.0 mm thick, and weighing 19.9 g (Figure 7.56). Edge damage is present on both left and right lateral margins along the length of the flake, with left lateral edge angle of 45° and right lateral edge angle of 30°.

UA99-62-135, modified flake

This specimen is a proximal flake of gray chert (C1) measuring 20.9 mm long, 25.6 mm wide, 4.9 mm thick, and weighing 2.4 g (Figure 7.56). Burin-like wear is evident on the distal and left lateral edges. Modification lengths are 9.1 and 6.3 mm and working edge angles are 85° and 70° respectively.

Spall Scrapers (n=8)

Eight spall scrapers were found in disturbed contexts at the Lower Locus, primarily eroding from disturbed sediments on the site grid or found on the slope below the site grid (Figures 7.57a and 7.57b). These items are similar in morphology, size, and damage type and location to Component 3 spall scrapers (see above). These disturbed samples were checked for possible refits with *in situ* materials for Components 2 and 3, but none refit. Table 7.27 lists disturbed spall scraper attributes. All variables were similar to Component 2 and 3 specimens.

Table 7.27 Disturbed spall scraper attributes.

Acc #	*MaxL*	*MaxW*	*MaxT*	*Wt.*	*Usewear*	*edge angle of use**	*NOTES*
UA2001-71-22	70.56	122.69	12.40	134.6	yes	20°	
UA2002-62-32	86.44	82.45	21.82	177.1	yes	30-40°	
UA99-62-36	94.51	129.14	22.16	308.8	yes	30-50°	
UA97-61-182	74.96	92.42	15.17	125.5	yes	20°	
UA2002-62-928	88.00	149.64	26.81	374.2	yes	25-60°	
UA2003-54-1227	71.01	66.57	14.68	71.9	yes	30°	broken on distal end
UA2001-71-1584	45.48	104.44	18.04	113.3	yes		unable to measure (undulating ventral surface)
UA2001-71-1586	50.57	72.50	10.50	37.4	yes	25°	

* generally ±10 degrees.

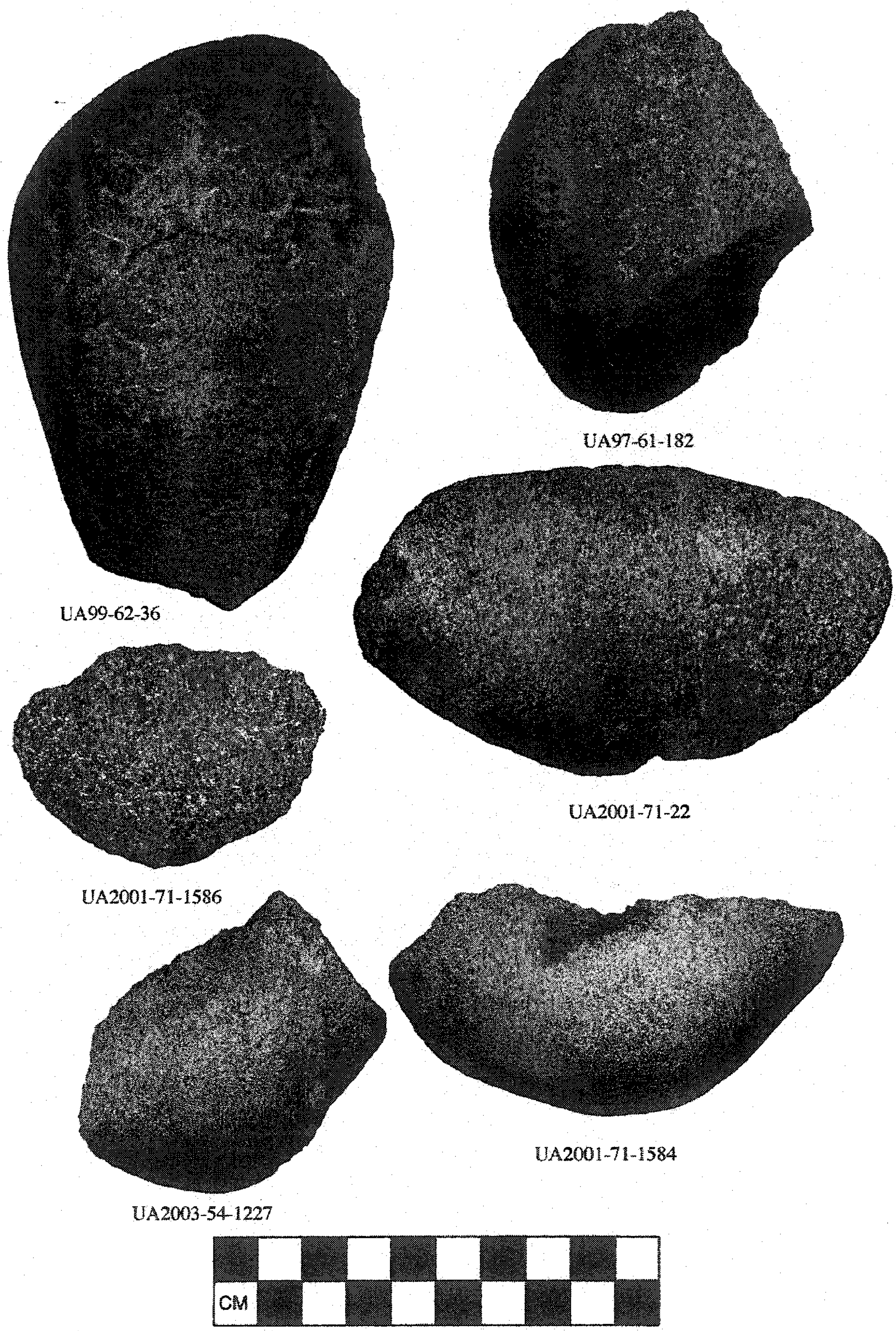
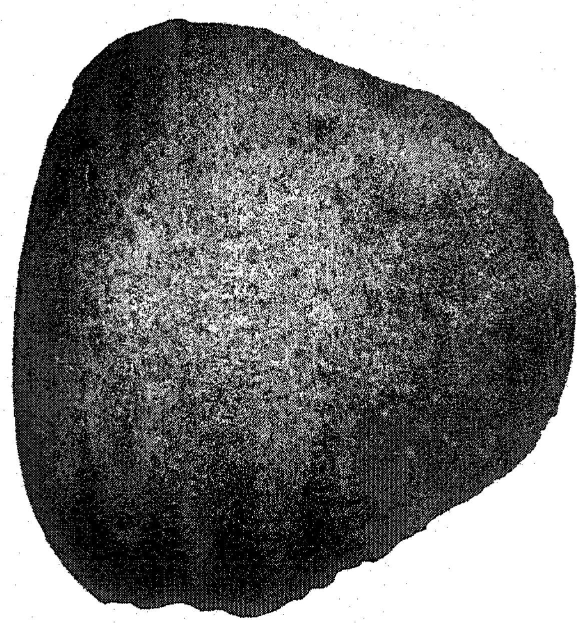


Figure 7.57a Spall scrapers from disturbed contexts.

UA2002-62-0928



UA2002-62-0032

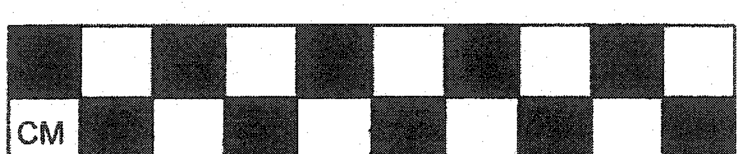


Figure 7.57b Spall scrapers from disturbed contexts.

Cobble Tools (n=5)

Five hammerstones were found in disturbed contexts at the Lower Locus. The hammerstones were made from rounded water-worn cobbles of coarse grained materials. Average maximum dimension is 11.9±4.3 cm, and average weight is 301.3±177.2 g.

UA2001-71-34, hammerstone/abrader?

This specimen is broken rounded cobble of relatively soft material measuring 11.2 cm by 5.3 cm by 5.2 cm and weighing 412.5 g. A notch is present on one side where abrasion from a resilient material is evident. This specimen may have functioned as an abrader.

UA2001-71-61, hammerstone

This specimen is a rounded cobble measuring 11.2 cm by 5.2 cm by 3.8 cm and weighing 285.0 g. Some battering is evident on the tip, but is very light and may be incidental.

UA99-62-209, hammerstone

This specimen is a rounded elongate broken cobble measuring 5.6 cm by 2.0 cm by 1.8 cm and weighing 31.8 g. Battering is present on one end.

UA97-61-181, hammerstone

This specimen is a rounded cobble measuring 17.0 cm by 4.9 cm by 3.8 cm and weighing 500.5 g. Battering is evident and a spall has been removed from one end.

UA97-61-183, hammerstone

This specimen is a broken rounded cobble measuring 14.7 cm by 5.4 cm by 2.6 cm and weighing 276.5 g. Battering is evident on the tip.

Unmodified flakes (n=171)

A total of 171 unmodified flakes were recovered from disturbed settings. No further analysis was conducted on these specimens.

Organic Artifact

With the faunal preservation at Gerstle River Component 3, it is interesting that only one organic tool was recovered. Faunal analyses indicate that animal portions were brought to the site and processed, followed by marrow extraction. No organic tool industry (with the exception of one specimen) was present in Component 3. No antler, horn, or hooves were found, suggesting that organic tools were not manufactured on site.

UA99-62-284, mammoth ivory rod

The worked mammoth ivory point or rod (Figure 7.58) was found 50 cm south of Feature 1. The point measures 23.8 cm long, 0.7-0.9 cm in diameter, and weighs 8.6 g. The cross-section near the tip is oval, and becomes flattened near the base. The specimen was broken about 4.5 cm below the tip. Upon recovery, the specimen fragmented into eight pieces. Discoloration near the tip suggests that the specimen may have been thermally altered.

Ivory rods are rare in Eastern Beringia, and long thin organic rods are even more rare, but there are a few specimens similar to the Gerstle River Component 3 rod. The Canyon Creek site (JfVg-1), located in Yukon Territory, Canada, produced a bone rod measuring 15.4 cm long, 1.0 cm wide, and 0.4 cm thick, with a flattened oval cross section (Workman 1974:100, Figures 5 and 6). The surface was eroded, and no human modification was observed. The specimen was associated with a hearth dated to 7195±100 BP (SI-1117), bifacial convex-based point, and bison (Workman 1974). Shorter and stouter bone points were found in muck deposits near Fairbanks, and were recently dated to about 8500 BP (Dixon 1999:53). A bone rod found at Broken Mammoth CZ 3 is interpreted to be a foreshaft, and ivory fragments from Broken Mammoth CZ 3 and CZ 4 are interpreted to be points and handles (Holmes 1996). Similar specimens have been found in Siberia in the late Upper Paleolithic, like Igheteyskiy Log I (21000-24000 BP), where three bone points were found, one measuring 340 mm long, and between 10 and 15 mm thick, also apparently broken in a similar fashion to UA99-62-284 (Medvedev 1998:125, also Figure 100.2). This specimen is slender and elongate, but the surface erosion could have modified its original dimensions. Given its morphology, this specimen may have functioned as a point.

While there are only a few examples of slotted implements in Eastern Beringia (see Chapter 8), some comparisons can be made with the Gerstle River specimen. Figure 7.59 illustrates the ivory point at Gerstle River and slotted implements recovered at Rice Ridge, Trail

Creek Cave 2, and Lime Hills Cave 1 (adapted from Steffian et al. 2002; Larsen 1968; and Ackerman 1996a) at the same scale. In terms of overall dimensions and morphology, the Gerstle River specimen is comparable to the slotted implements. While the Gerstle River point seems too slender to support unilateral or bilateral grooving, comparisons with these slotted specimens suggests that the former may have been a preform, but was discarded prior to slotting (perhaps due to the broken tip).

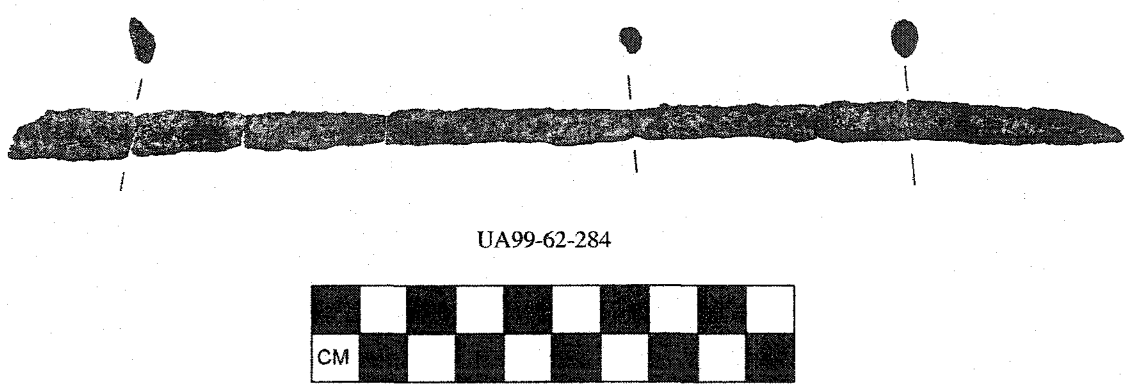


Figure 7.58 Component 3 mammoth ivory rod.

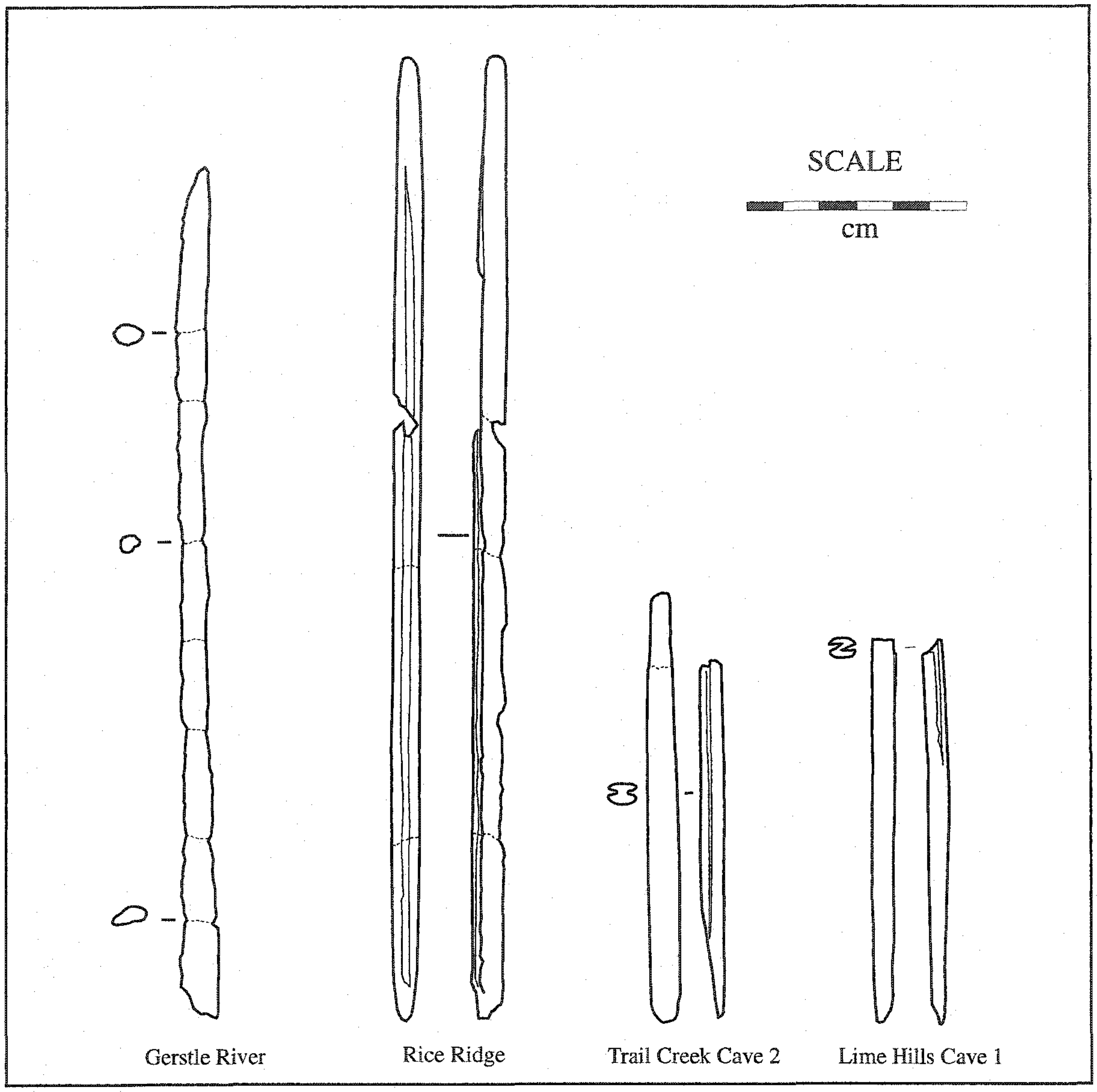


Figure 7.59 Gerstle River mammoth ivory point and selected slotted implements from Rice Ridge (adapted from Steffian et al. 2004), Trail Creek Cave 2 (adapted from Larsen 1968), and Lime Hills Cave 1 (adapted from Ackerman 1996a).

CHAPTER 8. TECHNOLOGICAL AND ECONOMIC ANALYSIS

Introduction

This chapter examines certain technological and economic aspects of the lithic assemblages from Components 1, 2, 3, 4, and 5 at Gerstle River. The analyses presented here are constrained by the nature of the lithic material present. The full lithic reduction sequence is not present, fabricators are uncommon (only a few hammerstones were found in Component 3), and the complexity of site structure complicates inferences about technological organization. To fully explore the latter subjects, a more regional framework is necessary, with detailed examination of lithic assemblages from a number of components. However, the lithic assemblage data present in the Gerstle River assemblages can be used to explore a number of issues relating to technological organization, and its relationship to site structure and site function.

Research questions related to lithic assemblages in any prehistoric site include delineation of classes and types of artifacts comprising the assemblage, characterization of lithic reduction strategies, and nature of material use or preference among assemblages. In addition, the clear spatial clustering necessitated an additional level of analysis. Gerstle River component assemblages offer an opportunity to analyze debitage and tools together in conjunction with well preserved faunal remains and hearth features. Understanding relationships among microblades, debitage, and tool attributes is a critical aspect of lithic analyses, and essential in the interpretation of each component.

There are a number of dimensions of technological organization of lithic assemblages, including (but not limited to) raw material availability (both abundance and scarcity), raw material quality, transportation costs (portability, size and weight of implements), procurement processes (logistically embedded or opportunistic), settlement strategy, mobility, tool efficiency (functionality, flexibility, versatility, and use life), tool formality (degree of regularization, standardization, and reduction stages), economic system (degree of specialization or generalization), activity sets (including intrasite variability), and site function (residential camps, field camps, locations (for extracting resources), and stations). These dimensions and their constraints on lithic technology have been widely used to interpret assemblages (Binford 1973, 1977, 1979, 1980, 1982; Torrence 1983; Bamforth 1986, 1991; Shott 1986, 1989; Parry and Kelly 1987; McAnany 1988; Nelson 1991; Kuhn 1994; Odell 1988, 1996; Carr 1994; Nash 1996). Variables that can be used to evaluate the effects of the dimensions on technological organization described above include degree of maintenance and recycling (measured here by debitage/tool ratios and percentage of modified margins on modified flakes), use of high quality lithic material types (maximization/curation), assemblage composition, and stages of lithic reduction present at each component.

The four main research problems relate to utilization of lithic raw materials, reduction strategies, tool use, and assemblage composition in each component at Gerstle River. Specific raw material questions relate to variations in patterning in lithic raw material use with respect to debitage, microblades, and non-microblade tools. Are there differences in material use or preference among components and tool classes? Is there an emphasis on high quality materials for formal tools and low quality materials for expedient tools? Is curation, maximization, and conservation of lithic raw materials reflected in each component? How can raw material use and transport be characterized? What are the relationships between discarded tools and debris of each material type? Variables used to address these questions are maximum dimension, weight, percent cortex, material type, tool formality, tool reuse, tool/debitage ratios, density, material quality, and flake type.

Specific reduction sequence questions relate to general stages of reduction, reduction sequences, percussor type, and variations in these characteristics among material types. Lithic assemblages may reflect tool production, tool maintenance, or mixtures of both. Beringian industries typically include both bifacial and core and blade reduction strategies. To what extent are these industries represented at Gerstle River? Can lithic acquisition, transport, use, and discard sequences be delineated at the site? What type of evidence exists for extensive resharpening, recycling, or retooling? Variables used to address these questions are flake type, flake weight, quantitative measurements, debitage density, percent cortex, and tool form.

Specific questions relating to lithic tool use include characterizing the regularization of tool types and functional variability of these implements. Given the predominance of microblade technology, a section is devoted to developing a model of microblade use at Gerstle River Components 2 and 3, utilizing data from other excavated components, and data on composite implements from Alaska and Siberia. Microblade technological characteristics from Components

2 and 3 are compared, and differences in microblade production are characterized. Technological data on microblades and modified flakes in Chapter 7 are used to address site function.

Specific assemblage composition questions relate to characterization of these assemblages with respect to generalized and specialized economic systems, curation, and mobility. Expectations relating to curation and expediency (see below) are evaluated against a number of assemblage variables in order to characterize the assemblages to allow for inferences about site function.

Several of these research problems relate to curation (Bamforth 1986; Shott 1989). Curation has been used by these and other authors as an important explanatory paradigm for assessing lithic technological organization. The link between curation and mobility has formed the basis for interpretation of many Upper Paleolithic assemblages, including those used by early North American groups (Kelly and Todd 1988). Some have suggested this relationship has been overstressed and in some cases overestimated, given the problem of equifinality with the other dimensions listed above (Nash 1996). While curation may be useful for very broad assessments about mobility at the level of cultural traditions and in interassemblage variability with large numbers of sites in varying regional contexts, given the similarities in technological traditions in the Late Pleistocene in Beringia (in both microblade core and blade and bifacial strategies), it may not be a useful paradigm for understanding technological organization at the level of site or assemblage. Essentially, the conservative use of raw material and the portability of early Beringian toolkits indicates high mobility (see below). In this context, inter-assemblage variability with respect to curation in Interior Alaska may simply reflect variations on a general theme.

As discussed in earlier chapters, evaluating technological organization among components at Gerstle River and addressing raw material use in this intrasite context may be a useful first step in understanding degrees of curation and perhaps differences in site use among components and spatial aggregates. Assemblages resulting from a curation based technological system would reflect multi-functionality (both versatility and flexibility), tools made in anticipation of future needs, and high formality (distinct types) (Bamforth 1986). Assemblages resulting from a more expedient technological system would reflect higher use of local raw materials, tool types manufactured onsite as needed, and less formality in tool design (i.e., tools are simpler in form and are less distinctive) (Bamforth 1986). These expectations are evaluated in this chapter.

The key to producing stronger inferences about technological organization and site use lies in assessing multiple lines of evidence, and evaluating the record in a contextual manner. The analyses conducted in this chapter are viewed as exploratory rather than explanatory, given the level of our current knowledge about site structure and assemblage structural variability in Alaska. While I may not be able to disentangle several interacting dimensions that affect technological organization, the descriptions provided here may prove useful in providing a base line for inter-assemblage comparisons for future work.

The three main analyses presented here encompass (1) debitage, (2) microblade industry, and (3) technological organization, the last incorporating data from the first two sections in addition to data from both formal and expedient tools (see Chapter 7). A variety of statistical and formal analyses are used to address the research questions listed above. Since spatial location was an important aspect of these questions (Chapter 10), the analytical database consisted of only those artifacts from secure stratigraphic contexts (n=10,098). Large cobble implements like spall scrapers and cobbles (n=24) were removed from the database, as their large weights skew density measurements and none of these were of material types used in lithic reduction on site, resulting in a database of 10,074 items. This database was imported into SPSS for statistical analyses (described below in each section) relating to these research questions.

Debitage Analysis

Methods

Lithic debitage (or flakes), as defined here, include flakes, flake fragments, and shatter (or angular debris). While this encompasses traditional classifications of debitage, this sample does not include special debitage forms, such as unmodified microblades, microblade core tablets, and (possibly) burin spalls.

There is no general consensus on which debitage attributes may be more useful in generating inferences about lithic technology. Numerous studies have examined the efficacy of various templates and methods for debitage analysis (Sullivan and Rozen 1985; Prentiss 1998, 2001; Ahler 1989; Bradbury and Carr 1995, 1999; Carr and Bradbury 2001; Magne 1985; Shott 1994; Cotterell and Kamminga 1987; Tomka 2001; Dibble and Pelcin 1995; Patterson 1990;

Rozen and Sullivan 1989; Healan 1995; Ensor and Roemer 1989; Baumler and Davis 2004; various papers in Amick and Mauldin 1989; see review in Andrefsky 2001, Magne 2001, and Sullivan 2001). Some archaeologists support individual flake analysis and others support mass analysis (see Shott 1994 for a general introduction to the former and Ahler 1989 for a general introduction to the latter). Efficiency, replicability, and power of discrimination are all criteria that are often used to evaluate performance of debitage analytical methods. Experimentation remains the key to producing valid methods for inferring lithic manufacturing procedures in archaeological contexts. Alaskan interior specialists generally focus on formal models of typology (Goebel 1990; Pontti 1997) in order to reconstruct lithic-related behaviors. Since archaeologists are in a very early stage of exploring debitage variability with respect to core and biface reduction in Interior Alaskan contexts, I have taken an exploratory approach here.

Several models of debitage analysis are combined here in the hopes of generating results from primary data that can be useful for future work in this region. The mass analysis and morphological analysis conducted here are described below. White's (1963) standard model of discriminating primary (defined as 50-100% cortex cover), secondary (1-50% cortex cover), and tertiary (no cortex) to infer lithic reduction processes was used (though see Ahler 1989; Mauldin and Amick 1989). Sullivan and Rozen's (1985) flake typology focused on completeness attributes (complete flakes, broken flakes, flake fragments, and angular debris), where different proportions of these types are thought to correspond with tool production (higher percentages of complete flakes and fragments), core reduction (higher percentages of complete flakes and shatter). Sullivan and Rozen's typology has been critiqued, primarily because of the lack of experimental linkages (Mauldin and Amick 1989), but many researchers have conducted experimental analyses with this in mind (e.g., Bradbury and Carr 1995; Prentiss 1998).

Mass analysis focuses on easily made and replicable measurements, generally weight and size classes (or grades) within an assemblage (Ahler 1989; Patterson 1990). However, only very broad generalizations can be made, and if assemblages are formed through mixed processes (such as core reduction and biface production), the resulting variation can often make the patterns difficult to interpret (Shott 1994).

A number of expectations are derived from the debitage analysis literature and compared with the Gerstle River data. Flake shapes vary for many reasons, including percussor size, weight, density, and material, cobble/nodule size and shape, platform type, and the skill of the flintknapper. For instance, flake shape variability can be produced by bipolar (narrow and heavier flakes) vs. bifacial thinning (broad and lighter flakes). Ahler (1989:91) notes that "average weight of flakes in a given size grade can measure variation in flake shape." Generally, a number of variables can reflect more intensive reduction, including platform preparation (multi-faceted, abraded, retouched), greater percentage of smaller flakes, and a lack of cortex. Core reduction produces higher frequencies of shatter and tool production produces higher percentages of broken flakes following Sullivan and Rozen's (1985) typology (Bradbury and Carr 1995; Magne 1985; Prentiss and Romanski 1989). Maximization of raw materials could be indicated through higher frequencies of platform preparation, low frequencies of cortical flakes, and non-local materials present as formal tools. Generally, lithic maintenance should be reflected in low lithic densities where lithic production should be reflected in high lithic densities (based on weight, not number of flakes). Amounts of cortex on flakes should provide a proxy for degree of reduction (Andrefsky 1998; White 1963; though see Ahler 1989; Mauldin and Amick 1989).

Flake size classes should be related to stage of reduction (large flakes in early reduction, and smaller flakes in later reduction) and percussor type (large flakes by percussion flaking, smaller flakes by indirect percussion, and tiny flakes by pressure flaking) (see Ahler 1989). Variations in size distributions may reflect different types of reduction (Shott 1994; Andrefsky 1998). Relationships between flake size and quality may reflect differences in conservation, with smaller flake sizes for exotic raw materials and larger flake sizes for more easily accessible local raw material. Maximization and conservation of lithic raw materials should result in low numbers of cortical flakes, formal tools primarily made from exotic (non-local) raw materials, late stage reduction (inferred through relatively small flake sizes), and high occurrence of platform preparation. Finally, comparisons of these debitage data among components may offer insights into differential use of raw materials at Gerstle River.

Mass Analysis Methods

A form of mass analysis was performed for all *in situ* debitage at the site excavated to date (see Ahler 1989). The sample includes every flake found *in situ* from all components at the site (n=8448). Variables are described in Chapter 7 and include size class, material type, material quality, type, form, item, maximum dimension, weight, and spatial location (in Area, Subarea, Cluster, see Chapter 10).

Unmodified debitage attributes are discussed here, as the size class template were also used to standardize and compare debitage, core, and tool dimensions. Debitage variables consisted of material type and maximum dimension, derived from size class templates subdivided in 5 mm increments up to 40 mm, and a larger size class of items 40 mm+ (Table 8.1). A number of size classes for waste flakes have been used in interior Alaska, most derived from 60° ellipses in Bowers (1980:109-110); see also Brauner 1968). The flake size template developed here, however, uses circles to record maximum dimension regardless of length and width, because (1) the Gerstle River collection contained various flake shapes, including linear and circular flakes, and (2) the Dry Creek debitage measurements used length and width measurements based on the same intervals (Hoffecker 1983b). Healy Lake analyses used weights (Cook 1969), so size measurements could not be compared.

Table 8.1 Size class parameters.

Size Class	*mm*	*in*	*Screen mesh (items retained)*
SC1	00-05	0.00-0.20	1/8" (0.13 in, 03.2 mm)
SC2	05-10	0.20-0.40	1/4" (0.25 in, 06.4 mm)
SC3	10-15	0.40-0.59	
SC4	15-20	0.59-0.79	
SC5	20-25	0.79-0.98	
SC6	25-30	0.98-1.18	1" (1.00 in, 25 mm)
SC7	30-35	1.18-1.38	
SC8	35-40	1.38-1.57	
SC9	40+	1.57+	

Since most non-microblade debitage was not weighed and that most microblade weights were below the scale threshold (0.1 g), weights based on size class (i.e., maximum dimension) were estimated for all lithic items not weighed. All weighed items below the scale threshold (0.1 g) were assigned weights of 0.03 g. Figure 8.1 illustrates measured weights per size class and the estimations derived from arithmetic means per size class. All items in SC7, 8, and 9 were weighed. SC6 (68% of all items weighed) average weights are 0.82±1.13 g, SC5 (58%) is 0.57±0.67 g, SC4 (40%) is 0.17±0.20 g, SC3 (24%) is 0.07±0.07 g, and SC2 (12%) is 0.03±0.02 g. All SC1 flakes that were weighed (5%) were below the measurement threshold, and were estimated at 0.03 g. This variable was labeled "modified weight."

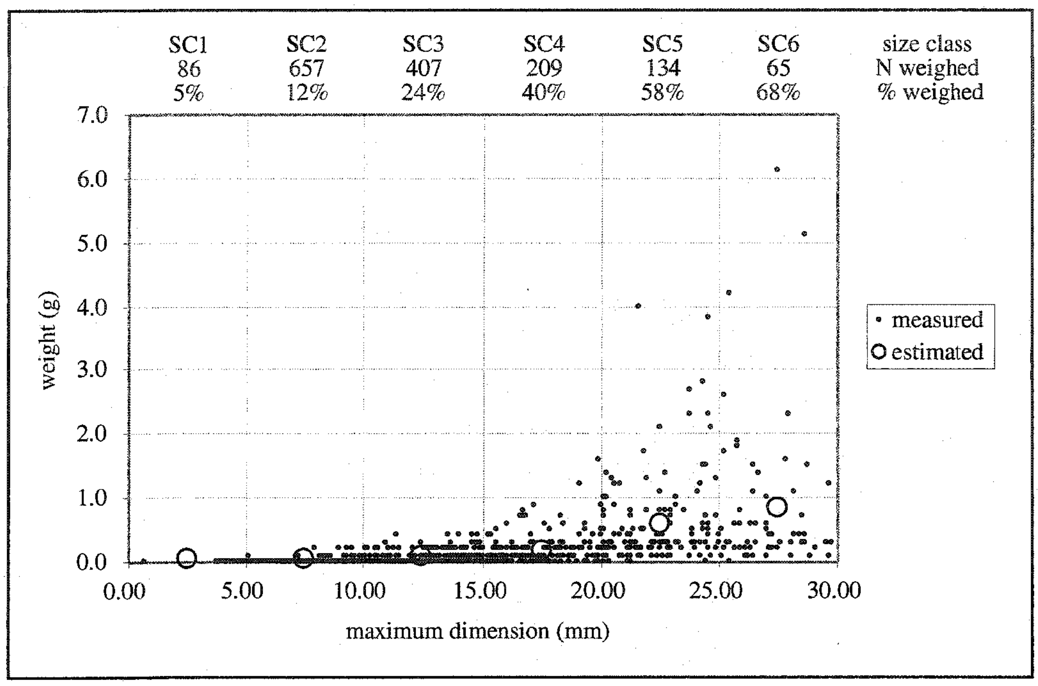


Figure 8.1 Estimation of flake weight.

Morphological analysis methods

A sample of debitage, consisting of debitage recovered in the 1999 excavation (n=1175, or 13.9% of all unmodified flakes), was examined using more variables for more detailed analysis. Variables included platform type, flake type (following Sullivan and Rozen 1985), weight, number of dorsal scars, and length, width, and thickness measurements on a number of specimens. The sample included 12 flakes from Component 1 (0.6% of total Component 1 unmodified flakes), 366 flakes from Component 2 (51.9%), and 797 flakes from Component 3 (14.3%). The distributions of unmodified flakes in this sampled area are illustrated in Figure 8.2. Component 1 materials are not considered adequately sampled, debitage in Components 2 and 3 are well sampled. Component 1 results are provided along with Components 2 and 3 for comparison, but any conclusions about the former should be considered very tentative.

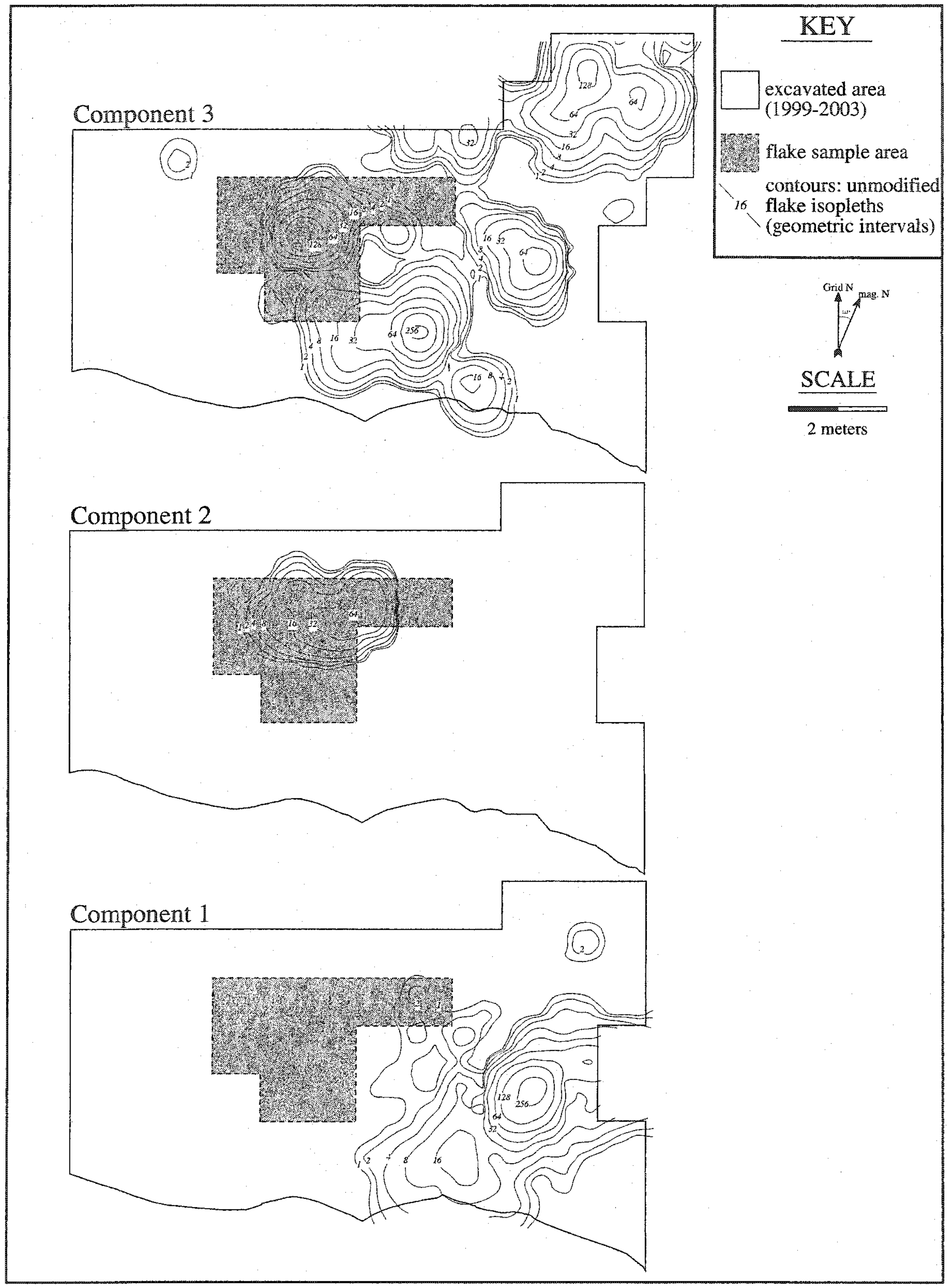


Figure 8.2 Location of flake sample and Components 1, 2, and 3 flake distributions.

Mass Debitage Analysis Results

Raw Material

Raw material frequencies for each component and material type by debitage, microblades, microblade core and core parts (microblade core tablets, facet rejuvenation flakes, microblade core fragments), and tools and tool fragments are presented in Table 8.2. For Component 1, C5, An, and Q predominate, with most tools made from C5. A single modified flake of Qa2 was apparently curated. For Components 2 and 3, materials can readily be separated on the basis of microblade production. In Component 2, Qa1, and R2 are not associated with any microblade technology. In Component 3, C2, C6, Ch3, and R1 are not associated with any microblade technology. A number of lithic tools appear to be curated and made from exotic materials for which few or no flakes are present, including J1 in Component 2 and C6, J2, and S in Component 3.

The lack of predominance of any one material type in any component further indicates that the site was not used for lithic production, and no lithic quarry has been located nearby. Rarely, degraded chert cobbles have been found in the nearby Gerstle River, but fine grained material outcrops or other sources have not been located.

Material types seem to be used in patterned ways at the Gerstle River site. A number of material types have no associated tools or microblades suggesting that they were used to refurbish or maintain non-microblade tools which were removed from the site. There appear to be preferences for different material types by tool class. High quality materials were generally used for microblade production, though moderate quality materials (such as R2 and Ar) were also used. Component 2 microblades were all manufactured on high quality cherts and chalcedonies, and all non-microblade materials were low to medium quality (Qa1 and R2). Component 3 microblades were primarily manufactured from high quality materials (62%), but 37% were made on medium quality materials (Ar, C4, R1, and others) and there were some 8 specimens of andesite microblades (low quality).

Within all components, bifaces were made exclusively on high quality chert (C1 and C5) with one made from medium quality rhyolite (R2). Burin spalls were made from the same materials as microblades, suggesting a relationship between the two artifact classes. All of the Component 3 burins were made from exotic materials, two of brown chert (C6) and one of gray banded chert (nominally C1, but different from most of the other gray chert). While one beveled flake was made of an exotic material (C6), the others were made on local materials (Ar, C1, and C4), suggesting that these implements could be curated as well as manufactured locally. Of the non-microblade formal tool classes (bifaces, burin spalls, burins, and beveled flakes), all but burins could have been refurbished on site. The burins are made of different materials than the microblades, suggesting that they may have been part of a different aspect of the toolkit.

Modified flakes were the only tool class with enough specimens to compare with debitage distributions. Figure 8.3 compares modified flakes and debitage for each material type and component. Components 1 and 2 are similar in that modified flakes were generally manufactured from materials with relatively few unmodified flakes, except for C5 in Component 1, which had high relative frequencies of both. The situation is reversed in Component 3, where most of the modified flakes are generally present in roughly equal quantities with debitage (except siltstone). This suggests that modified flakes within Component 2 were manufactured elsewhere and discarded on site, whereas modified flakes within Component 3 were manufactured from blanks available on site. However, the difference in size between modified and unmodified flakes (see Figure 7.46) indicates that either (1) nearly all of the larger flakes produced on site were used as tools, or (2) these modified flakes were manufactured elsewhere and discarded on site. Given the limited evidence of core reduction or early stage bifacial reduction, it is argued here that at least some of these flakes were manufactured elsewhere. Relationships between discarded tools and flake clusters based on material type are assessed in the spatial analysis section (Chapter 10).

Materials in Components 2 and 3 were compared for differences in size relating to their association with microblade technology. Materials Qa1 and R2 in Component 2 and C2, Ch3, and R1 in Component 3 represent non-microblade materials. Materials C1 and Ch1 in Component 2 and An, Ar, C1, C4, C7, C9, O, and R2 in Component 3 represent microblade materials. Further analyses are conducted within the spatial analysis (Chapter 10).

Table 8.2 Gerstle River material types by component and technology.

Component	*Debitage*		*Microblades*		*Microblade cores and core parts*		*Tools and tool fragments*	
	N	*%*	*N*	*%*	*N*	*%*	*N*	*%*
Component 1	2034	100.0					6	100.0
An	107	5.3						
C5	1764	86.7					5	83.3
Qa2							1	16.7
Q	163	8.0						
Component 2	705	100.00	102	100.00	9	100.0	12	100.0
C1	16	2.3	34	33.3	2	22.2	8	66.7
Ch1	295	41.8	64	62.7	7	77.8	3	25.0
Ch2	39	5.5	3	2.9				
J1			1				1	8.3
Qa1	329	46.7						
Qa2	1	0.1						
R2	25	3.5						
Component 3	5591	100.0	1344	100.0	30	100.0	105	100.0
An	111	2.0	8	0.6				
Ar	237	4.2	196	14.6			3	2.9
B	4	0.1						
C1	2657	47.5	704	52.4	19	63.3	69	65.7
C2	554	9.9						
C3	1	0.0	23	1.7				
C4	747	13.4	97	7.2	4	13.3	16	15.2
C6							5	4.8
C7	121	2.2	66	4.9	5	16.7	7	6.7
C8	3	0.1	1	0.1				
C9	85	1.5	11	0.8				
Ch2	16	0.3	1	0.1				
Ch3	138	2.5						
D	8	0.1						
J1	1	0.0	4	0.3				
J2							1	1.0
O	38	0.7	39	2.9				
R1	234	4.2						
R2	633	11.3	194	14.4	2	6.7		
S	3	0.1					4	3.8
Component 4	32	100.0	1	100.0			10	100.0
C4	32	100.0	1	100.0			9	90.0
C6							1	10.0

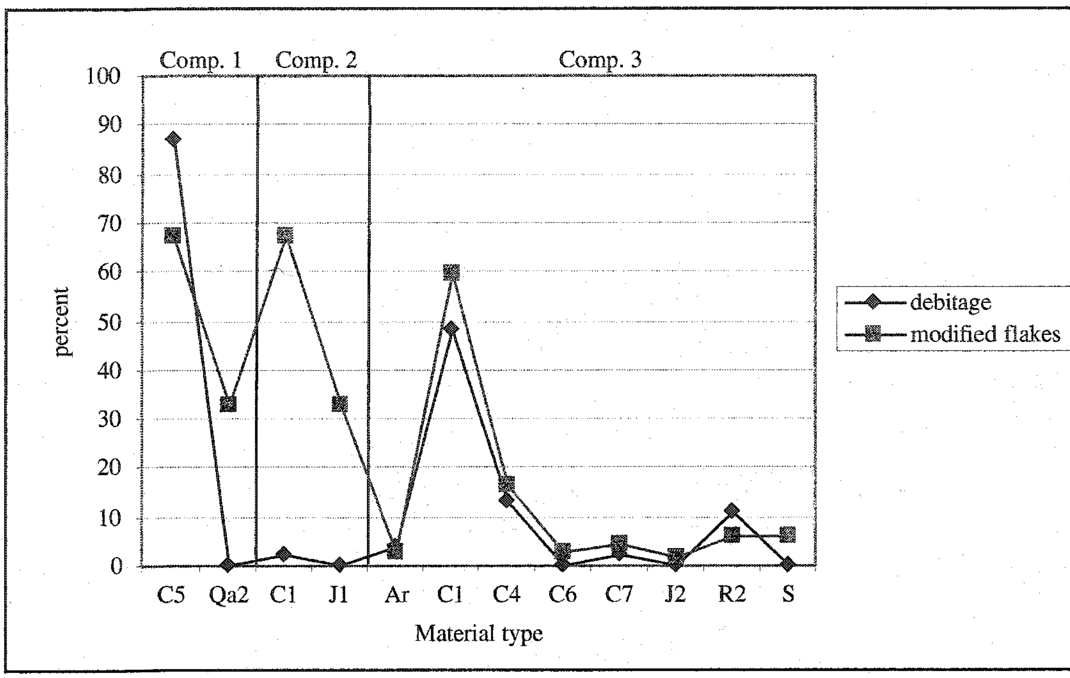


Figure 8.3 Modified flakes and debitage by material type and component.

Quantity and Density

Number of flakes and total weight, along with fragment density and weight density can be used to assess lithic reduction intensity among components and areas. Table 8.3 lists analytical area (defined as number of excavation units where n≥1 flake was recovered), number of flakes, total weight (based on modified weight), flake density (number of flakes/m^2), and weight density (g/m^2). Two groups of components are discriminated on the basis of fragment density and weight density. Components 1, 2, and 3 have fragment density of around 65 flakes/m^2, and 3.5 g/m^2, whereas Components 4 and 5 have low flake densities (4 to 17 flakes/m^2) and low weight densities (~0.5 g/m^2). Since assemblage diversity (number and types of tool classes) are substantially different among the components, it is argued here that these density values reflect general lithic reduction intensity of the occupations. In other words, Components 4 and 5 represent rather brief occupations, where few lithic items were maintained or refurbished, and Components 1, 2, and 3 represent relatively higher intensities of lithic maintenance and other activities.

Table 8.3 Debitage frequency, weight, and density.

Group	*Analytical Area (m^2)*	*N flakes*	*Total wt. (g)*	*Flake density (n flakes/m^2)*	*Weight density (g/m^2)*
Component 1	33.0	2034	141.39	61.6	4.3
Component 2	11.0	705	33.30	64.1	3.0
Component 3	75.0	5591	279.00	74.5	3.7
Component 4	8.0	32	1.90	4.0	0.2
Component 5	5.0	86	2.78	17.2	0.6

Size Classes

Size class data for each component by material type are illustrated in Figures 8.4-8.8. In general, the components were very similar in having relatively few flakes over 15 mm in maximum dimension. Summaries are provided here for each component.

The majority of Component 1 flakes were in size class 8 (5-10 mm) for each material type (Figure 8.4), however they are considerably larger than flakes in Components 2 and 3 (see Figures 8.5 and 8.6). Andesite and quartzite flakes are larger than green chert flakes (C5), with higher percentages of size classes 4, 5, and 6 (15-30 mm). Green chert and andesite flakes are unimodally distributed and left skewed, but andesite has a bimodal distribution, size classes 4 and 2, suggesting a different reduction sequence or different uses of this material.

Component 2 flakes are primarily between 5-10 mm (size class 2) for each material type. Figure 8.5 illustrates size class distributions for all material types with greater than 15 flakes. C1, Ch1, and Qa1 material types show similar unimodal distributions, with relatively few flakes greater than 15 mm in maximum dimension. Ch2 has a flatter distribution, with nearly equal amount of size class 2 and 3 flakes. R2 flakes are relatively higher frequencies of smaller flakes (size class 1) and larger flakes (size classes 3, 4, 5, and 6) than the primary material types, though the sample size is small. The dichotomy between materials associated with microblade production (C1, Ch1, and Ch2) vs. Qa1 and R2 suggests they are the result of different lithic reduction processes. Based on the size class data, Qa1 and R2 concentrations may have resulted from biface reduction or tool resharpening.

Component 3 flakes was similar to Component 2 in size class distributions, with the majority between 5-10 mm (size class 2) for each material type. Figure 8.6 illustrates size class distributions for all material types with greater than 30 flakes. Most of the material types show similar unimodal distributions, with relatively few flakes greater than 15 mm in maximum dimension. Chalcedony (Ch3) is represented by more size class 1 flakes (0-5 mm). Gray rhyolite

(R1) and white rhyolite (R2) show similar distributions with relatively fewer size class 2 flakes and more size class 1 flakes. This may be the result of material constraints as R1 is associated with biface reduction based on spatial analysis and lack of R1 microblades, and R2 is associated with microblade production. Andesite (An) has a greater representation of size class 8 flakes than the other material types. The fact that the size class distributions are so similar suggests that most of the materials at Component 3 represent similar stages in the reduction sequence, namely microblade production and tool maintenance.

Component 4 flakes were similar to Component 2 and Component 3 flakes in size. Figure 8.7 illustrates size class distributions for Component 4. The distribution is unimodal, with 63% of flakes in size class 2 (5-10 mm).

Component 5 flakes were generally small in size, with the majority in size class 2 (5-10 mm) for each material type. Figure 8.8 illustrates size class distributions for all material types with greater than 15 flakes. The material types show similar unimodal distributions, with relatively few flakes greater than 10 mm in maximum dimension, though there are a few size class 3 obsidian flakes.

Size class data show that Component 1 differs from Components 2 and 3, with relatively more size class 3 and 4 flakes (10-20 mm) and relatively fewer size class 1 and 2 flakes (1-10 mm) (see Figures 8.4-8.8). Components 2 and 3 are very similar, though individual material types show considerable variation. Variability in debitage size distributions may relate to reduction type (Andrefsky 1998; Shott 1994), and the low variability exhibited at Gerstle River suggests that tool maintenance was the primary stage of reduction in these Components. Hard hammer percussion flaking generally produces much larger flakes than pressure flaking (Ahler 1989), and the small sizes of flakes coupled with the rarity of hammerstones in Components 2 and 3 support the idea that soft hammer percussion, indirect percussion, and pressure flaking were more prevalent.

Relationships between flake sizes and raw material quality may relate to conservation of some materials, but the overall similarities suggest either (1) that very little conservation of specific raw materials was evident, or (2) that the general stages of reduction at each component are characterized as tool maintenance, and therefore the size distribution would reflect similar patterns of generally small to tiny retouch flakes. Given the preponderance of evidence at this site (see below and Chapter 7), the second alternative is considered more likely.

The fact that all components, spanning over 4000 years, all are characterized by very small flake sizes, strongly indicates that a lithic quarry or raw material source is not located nearby, or at least was not exploited during the occupations at Gerstle River.

Given these patterns and the tool class data from each component, I argue that tool maintenance and microblade production do not produce significantly different sizes of debitage. The primary constraints on raw material use are likely to be related to the raw material sources, preferences relating quality to certain tool classes, and activities at the site. These patterns are consistent with the interpretation of use of the Gerstle River site as a camp location rather than a specialized flaking station (e.g., for biface or core reduction).

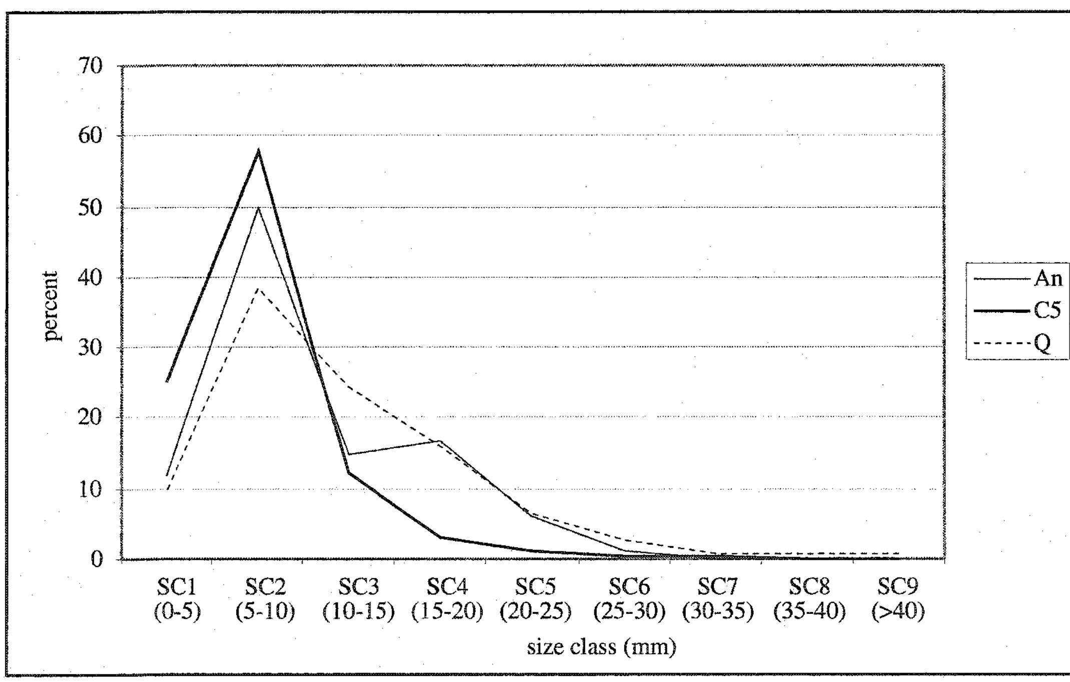


Figure 8.4 Component 1 flake size classes by material type.

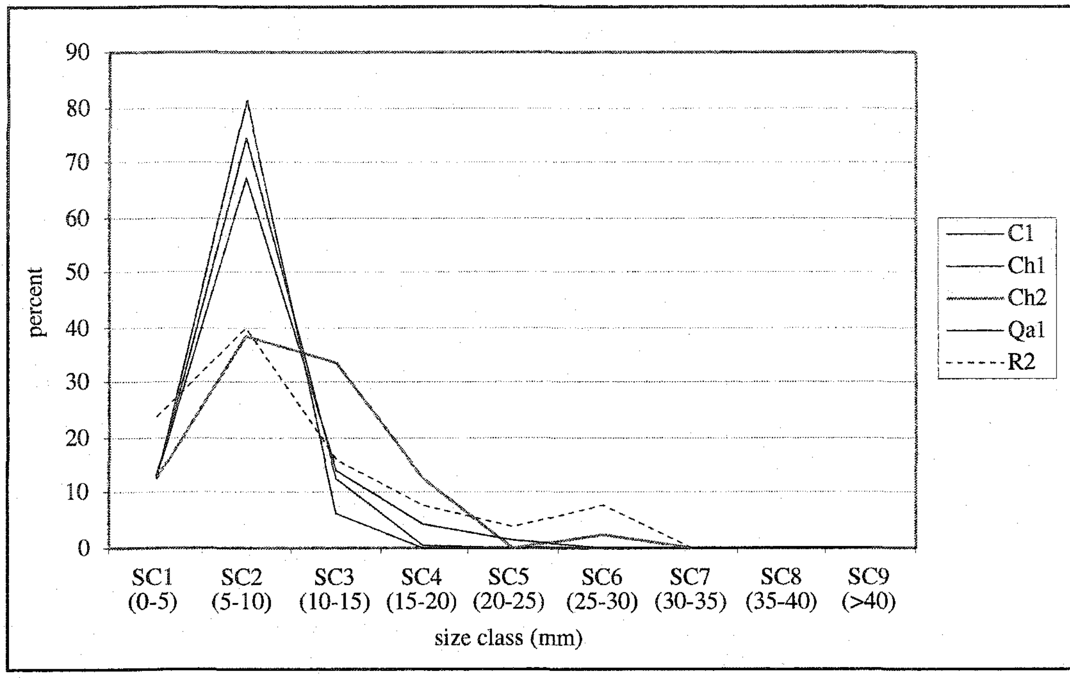


Figure 8.5 Component 2 flake size classes by material type (where n>15).

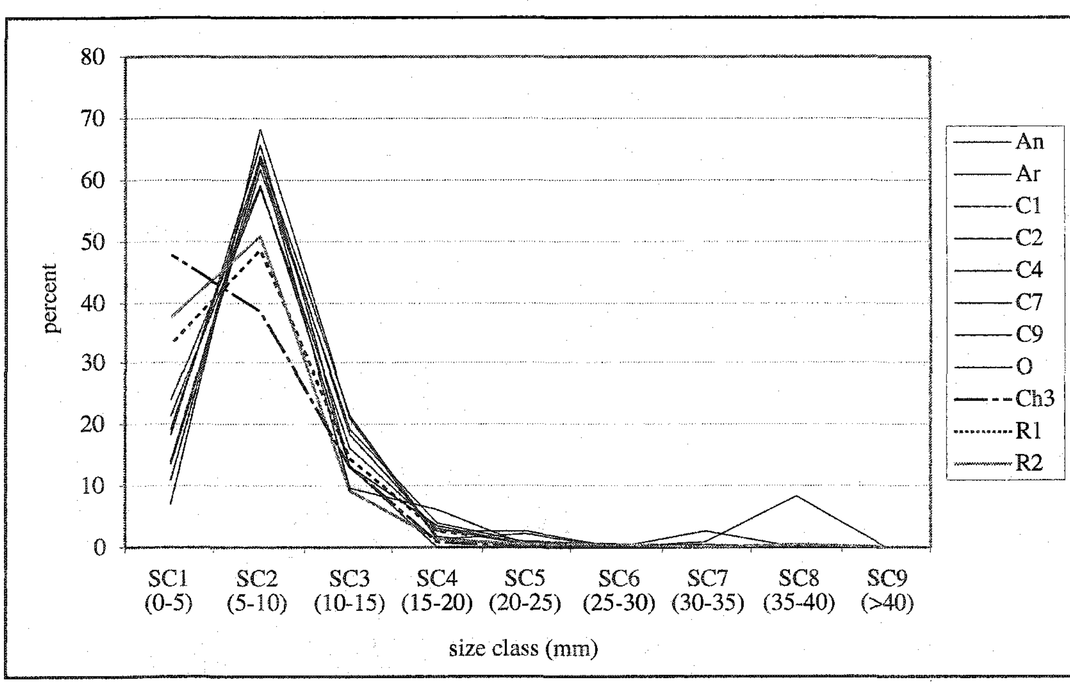


Figure 8.6 Component 3 flake size classes by material type (where n>30).

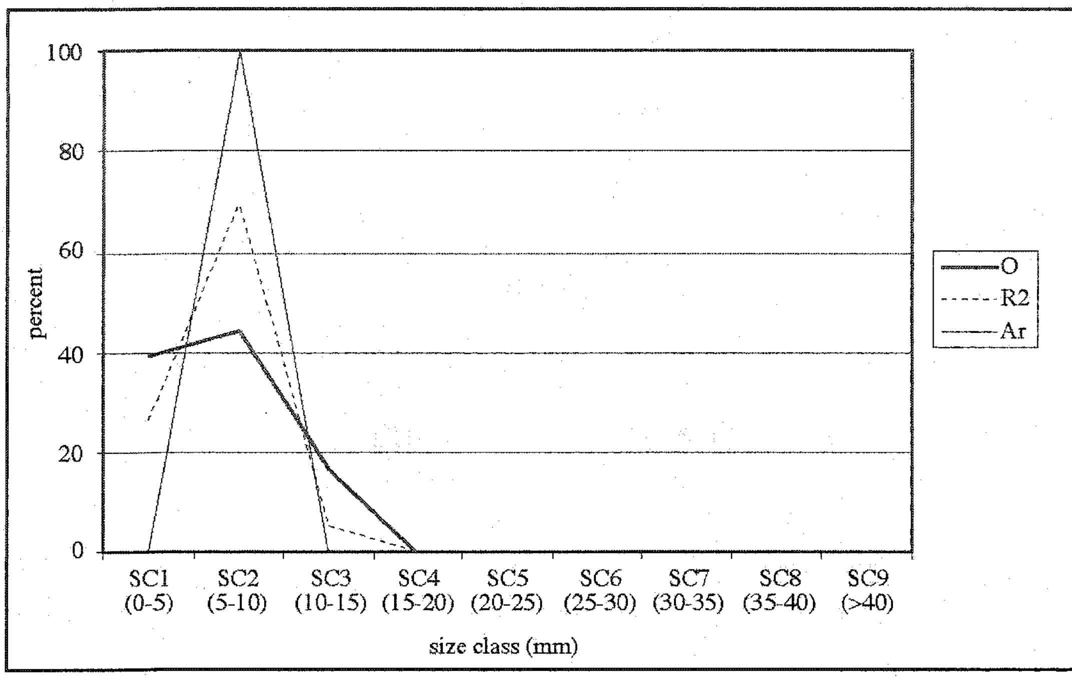


Figure 8.7 Component 4 flake size classes.

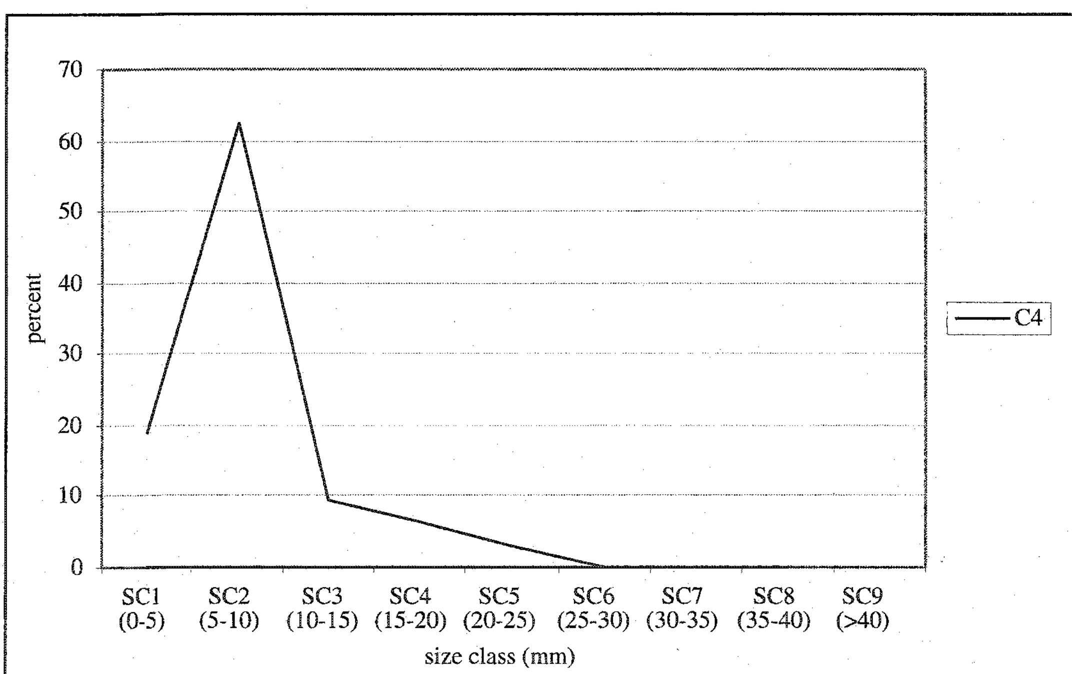


Figure 8.8 Component 5 flake size classes by material type.

Morphological Debitage Analysis Results

Results of the typological debitage analysis indicate that there are patterned differences and similarities among Components 1, 2, and 3. Flake type results are presented in Table 8.4. Component 2 contains relatively more complete flakes and fewer flake fragments than Component 3. These patterns are present for most of the material types within each of the components, though there are minor differences. Component 3 material types range from 12-23% complete flakes, where Component 2 material types range from 20-52% complete flakes. Component 2 material type R2 was not associated with microblade production, and had the lowest percentage of complete flakes and highest number of flake fragments. The same was true of Component 3 material type C2, though R2 in had values more in line with other material types associated with microblade production (C1, C4). Sullivan attributes high percentages of flake fragments (distal fragments) to tool manufacture and higher numbers of complete flakes to core reduction (2001:196). Given the numerous core tablets from Component 2 in this area, including a sequence from an early stage of core reduction (see Chapter 7), the flake type ratios seem to support this assessment.

A number of researchers suggest that core reduction and tool production produce greater relative frequencies of shatter and broken flakes respectively (Magne 1985; Prentiss and Romanski 1989; Bradbury and Carr 1995). The low relative frequencies of shatter and moderate frequencies of broken flakes in Components 2 and 3 do not support core reduction, but may support core maintenance.

Degree of non-cultural breakage can also be inferred from this typology. The variability between material types for each component (especially Component 2) supports the contention that post-depositional turbation resulting in broken flakes is not evident at Gerstle River Components 2 and 3. Though the sample size is small, the higher percentages of flake fragments in Component 1 could result from contact and abrasion with the colluvial cobbles and pebbles in Unit VII.

Fabricator type has a profound effect on percentages of complete flakes, and Mauldin and Amick (1989) found that antler billets produced fewer complete flakes than hammerstones (15% vs. 60%). The percentages of complete flakes vary by component and material type at Gerstle River, with Component 3 having far fewer complete flakes. While blades can be produced through direct percussion, indirect percussion, and pressure flaking (Crabtree 1972), antler billets are presumed to be used to detach microblades through indirect percussion (see Flenniken 1987), however, the differences in complete flake percentages could also result from trampling (Prentis and Romanski 1989). The differences in variability of flake fragment frequencies between Components 2 and 3 by material type (18-60% in Component 2 vs. 44-58% in Component 3) suggests that trampling may have been more of a factor in Component 3, supported by the many activity areas, possible re-occupation, and presence of faunal clusters of multiple individuals (see Chapters 5, 6, and 10).

Table 8.4 Flake type results.

Component	*N*	*Complete flake*	*Broken flake*	*Flake fragment*	*Shatter*
Component 1 (C5)	12	1 (8%)	1 (8%)	10 (83%)	0
Component 2	366	175 (48%)	96 (26%)	82 (22%)	13 (4%)
C1	10	3 (30%)	2 (20%)	4 (40%)	1 (10%)
Ch1	292	153 (52%)	77 (26%)	54 (18%)	8 (3%)
Ch2	39	14 (36%)	13 (33%)	9 (23%)	3 (8%)
R2	25	5 (20%)	4 (16%)	15 (60%)	1 (4%)
Component 3	797	122 (15%)	154 (19%)	425 (53%)	96 (12%)
C1	195	45 (23%)	42 (22%)	85 (44%)	23 (12%)
C2	553	67 (12%)	102 (18%)	320 (58%)	64 (12%)
C4	6	1 (17%)	2 (33%)	3 (50%)	0
R2	18	6 (33%)	3 (17%)	8 (44%)	1 (6%)

Platform types were relatively similar among components, with the majority single faceted (between 66-72% for Components 2 and 3 (Table 8.5). There were fewer occurrences of multi-faceted platforms, but relatively high percentages of platforms modified through abrasion, retouch, or crushing (25-32%) for Components 2 and 3. The higher percentages of modified platforms suggests more intensive reduction may have occurred within Component 2. Only 3% of Component 2 flakes and 13% of Component 3 flakes had lipped platforms, suggesting higher frequencies of soft-hammer bifacial reduction in Component 3 (Frison 1968).

Table 8.5 Platform type results.

Component	*N*	*Absent (not counted in percentages)*	*Single facet*	*Multi-facet*	*Abraded/ retouched/ crushed*
Component 1	12	10	1 (100%)	0	0
Component 2	366	98	177 (66%)	6 (2%)	85 (32%)
Component 3	797	518	198 (72%)	9 (3%)	68 (25%)

Cortex was extremely rare, found on only one flake within the Component 2 sample, and none in the Components 1 or 3 samples. The Component 2 specimen had approximately 25%

cortex. Frequencies of cortex should relate in a basic way to stage within a lithic reduction sequence, with high frequencies of primary cortical spalls (>50% cortex) related to early reduction, high to low frequencies of secondary spalls (5-50% cortex) to middle stages of reduction, and very low to no dorsal cortex to late stage reduction, tool production, and maintenance (White 1963). There are problems with such a simple model (Ahler 1989; Mauldin and Amick 1989), however, while absence of cortex does not necessarily indicate later stages of reduction, presence should indicate relatively early reduction from parent nodules. Cortex is present on a small number of items in Component 3 not in this sample, such as modified flakes (see Chapter 7), however the fact that the few pieces with cortex are also relatively large modified flakes further supports the hypothesis that early stages of lithic reduction did not occur at Gerstle River. Cortex can also be useful for estimating sizes of parent nodules (Bradbury and Carr 1995). The few specimens found at Gerstle River Component 3 indicate that the parent nodules were likely river worn cobbles of about 10 cm diameter, but this is tentative given the very small sample size.

Dorsal scar count can be used to infer general stages of reduction or intensity of reduction (Magne 1985; Odell 1989) (Table 8.6). Higher numbers of dorsal flake scars can result from more intensive reduction. Components 2 and 3 are very similar in dorsal scar counts, generally evenly distributed between 2 and 3, and 28% and 22% respectively have four or more scars. Flakes with 3 or more dorsal scars are considered by Magne to be indicative of late stages of reduction (Magne 1985:120; see also Odell 1989; Ingbar et al. 1989).

Table 8.6 Dorsal scar count results.

Component	*1*	*2*	*3*	*4*	*>4*
Component 1	0	3 (25%)	5 (42%)	2 (17%)	2 (17%)
Component 2	28 (8%)	103 (29%)	122 (35%)	54 (15%)	46 (13%)
Component 3	114 (15%)	240 (33%)	240 (31%)	83 (11%)	81 (11%)

Other flake attributes were examined, such as thermal alteration and presence of specific flake types, such as bifacial thinning flakes and bipolar flakes (Table 8.7). No bipolar flakes were observed, but low percentages of bifacial thinning flakes were found in all three components. In both Components 2 and 3, bifacial thinning flakes were generally limited to materials not associated with microblade production, R2 and C2. No bifaces were found in any of these areas in either component, and their small sizes suggest maintenance. While no thermal alteration was found in the Component 1 or 3 samples, 8% of Component 2 flakes were burned (Table 8.7).

Thermal alteration consisted of heat pitting (potlids) and crazing on ventral and dorsal surfaces. Thermal alteration was found on three of the four material types in various degrees (4-28%). Material Ch2 was significantly more heat damaged than the others (χ^2=30.8, df=3, p≤0.001), suggesting that the reddened color may have resulted from heating. Since the spatial distribution of burned flakes corresponds closely to hearth Feature 2, and the artifact distribution is tightly clustered around Feature 2, these materials may not have been purposefully heated. The Ch1 material type is characterized as high quality chalcedony with few material defects (cleavage planes, inclusions, etc.).

Table 8.7 Qualitative debitage variable summaries.

Component	*N*	*Bifacial thinning flake*	*Thermal alteration*
Component 1	12	1 (8%)	0
Component 2	366	9 (2%)	28(8%)
C1	10	0	0
Ch1	292	4 (1%)	13 (4%)
Ch2	39	0	11 (28%)
R2	25	5 (20%)	4 (16%)
Component 3	797	35 (4%)	0
C1	195	4 (2%)	0
C2	553	28 (5%)	0
C4	6	0	0
R2	18	3 (17%)	0

In summation, the morphological debitage analysis indicates that the lithic reduction sequences at Gerstle River Components 2 and 3 primarily reflect microblade production and associated core rejuvenation and maintenance, as well as non-microblade tool maintenance (unifaces and bifaces). No evidence of early stage core reduction or biface manufacture is present. Component 1 data is sparse, but in conjunction with the mass analysis, tool maintenance or possibly late-stage flake core or biface reduction may be represented.

Microblade Industry Analysis

The results of detailed microblade analyses for Components 2 and 3 in Chapter 7 demonstrate varied uses of microblades at Gerstle River. This section integrates data from microblade sites with attendant slotted organic points, spatial and technological data from Dry

Creek Component 2, the largest excavated microblade component in Interior Alaska, and tests various models of microblade use in Interior Alaska.

Comparison of Gerstle River Components 2 and 3

In general, the microblade industries present at Gerstle River Components 2 and 3 are very similar. Microblade core reduction is similar, with similar forms of platform and facet rejuvenation flakes. Both are characterized by the relative paucity of complete cores. Microblade and microblade core and core parts data from Chapter 7 show that a number of similarities and differences existed between Components 2 and 3. Comparisons are shown in Table 8.8 along with t-test results. Component 3 microblades are generally shorter, wider, thicker, and lighter than Component 2 microblades. Much of these differences are due to differences in segment frequencies (Table 8.9, Figure 8.9). Component 2 has relatively more complete microblades and fewer medial segments than Component 3.

While these differences may seem to reflect differences in microblade utilization or production at the level of components, when spatial differences are factored in, a different pattern is seen. Areas A, B, and C are very similar to each other and different from Component 2 (Area E), however Area D is very similar to Component 2 (Figure 8.9, see Figure 10.7 for area locations). While microblade core tablets were recovered in low frequencies in Areas B and C, only Area D had microblade cores associated. This pattern could be a signal reflecting two different aspects of microblade production and use. Areas with depleted medial segments may reflect microblade production and selection, removal, and production of composite tools, whereas areas with more equal percentages of proximal and medial segments may reflect maintenance of composite tools. In other words, the former activity may result in more medial depletions, and the latter activity may result in fewer medial depletions. Relatively fewer end modified and laterally retouched microblades are found in Component 2 and Area D (9-11 vs. 17-38), suggesting that removal and discard of used insets from composite tools may be associated with Component 3 Areas A, B, and C, whereas production of microblades for use in newly crafted composite points may be reflected in Component 2 and Component 3 Area D. The co-occurrence of microblade cores and core tablets with the latter areas suggests that composite tool production may be associated with more intensive microblade core reduction than composite tool maintenance.

More detailed analyses with respect to spatial organization at both components are presented in Chapter 10. Tasks relating to microblade production, removal and discard of microblade insets, microblade use, and non-microblade tool maintenance are also examined in Chapter 10.

Table 8.8 Microblade assemblage variables and tests for Components 2 and 3.

Variable	*Component 2 (n=105)*	*Component 3 (n=1350)*	*Test statistic (t)*	*df*	*p*
L	13.8±9.0	11.2±6.3	3.92	1450	0.000
pW	4.9±1.4	5.9±1.6	-6.11	1449	0.000
pT	1.1±0.5	1.4±0.5	-5.54	1450	0.000
T/W index	23.6±7.5	24.3±7.4	-0.91	1449	0.365 ns
Mod_weight	0.10±0.16	0.08±0.13	1.46	1453	0.144 ns
N arrises	1.63±0.72	1.65±0.64	-0.38	1450	0.706 ns
Cross section (% triangular)	46.7%	43.3%	-0.67	1449	0.505 ns

Table 8.9 Microblade segmentation for Components 2 and 3.

Group	*N*	*Complete*	*Proximal*	*Medial*	*Distal*	*End modified*	*Lateral retouch + major damage*
Component 2 total Area E	105	14%	44%	23%	19%	4	5
Component 3 total	1350	3%	41%	36%	21%	31	65
Area A		1%	39%	39%	20%	4	13
Area B		3%	38%	39%	19%	14	24
Area C		3%	40%	39%	18%	9	21
Area D		4%	46%	24%	25%	4	7

Composite Tools

While no composite tools or slotted organic implements were recovered at Gerstle River, it is almost certain that microblades were used as insets into such items given their size, morphology, thickness, and presence of composite tools in Beringia. Data from sites with composite tools and microblades are used to examine the Gerstle River Component 2 and 3 microblade industries.

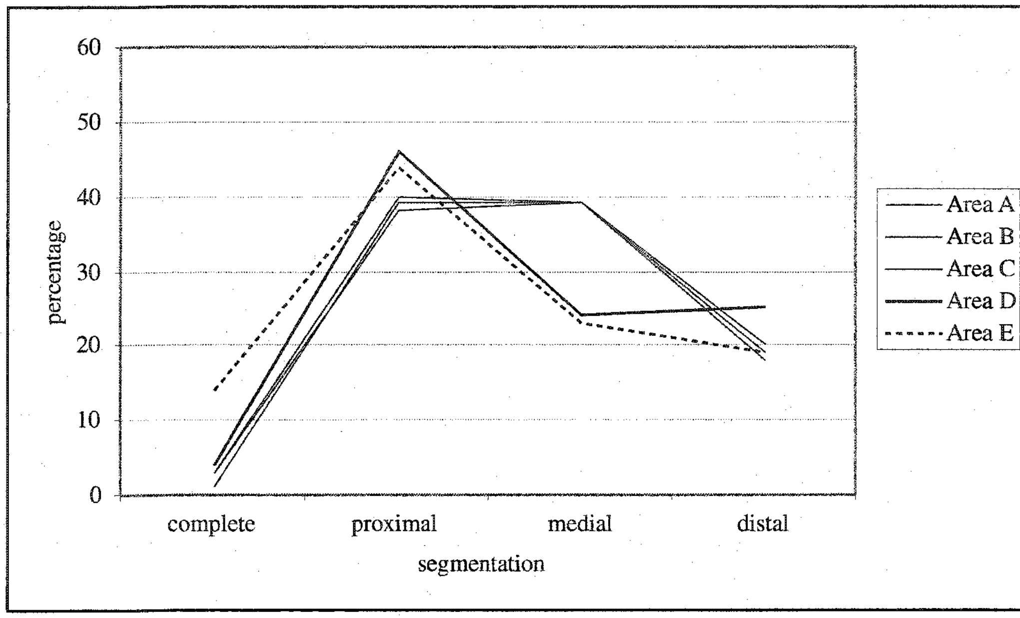


Figure 8.9 Segment representation by Area for Components 2 (Area E) and 3 (Areas A-D).

While over 300 sites with microblades are known in Interior Alaska (Potter 2000), only five sites have associated slotted implements are known for Eastern Beringia (Alaska and Yukon Territory): Trail Creek Caves, Cave 2 (7 tools), Ilnuk (1 tool), Lime Hills I (1 tool), Gladstone Ice Patch (1 tool), and Rice Ridge (11 tools), for a total of 22 slotted organic implements. Data on these items are provided in Table 8.10, along with a number of Siberian sites with microblades and slotted tools dating to the Late Pleistocene or Early Holocene. Outlines and cross sections of most of these implements are shown in Figure 8.10 to the same scale.

Slotted implement material types are varied, especially within Siberia, however, most of the Eastern Beringian implements are made from antler. Cross sections are generally oval, but lengths vary considerably (Figure 8.10). Positions of grooves are varied, both unilateral and bilateral. The width of the grooves is generally between 1.5 and 2.0 mm and the depth is around 3 mm. The largest sample size in Eastern Beringia is at Rice Ridge (Steffian et al. 2002). One complete preform was found (185 x 11 x 10 mm), along with five medial and eight basal fragments. Cross sections are generally centered at the lateral margins (I-shaped cross-section), though the Lime Hills I sample is bilateral and off-set (S-shaped cross-section). Very few complete composite tools have been recovered, but the data suggest that the dimensions are generally over 100 mm long by 5-10 mm wide, and are thus rather elongate, slender points. The complete dart slotted projectile found at Gladstone Ice Patch is 246 mm long by 10 mm wide.

Table 8.10 Slotted implement measurements associated with microblades in Alaska and Siberia (all measurements in mm).

Site	*N*	*Material*	*Dimensions (LxWxT) (mm)*	*Position of groove*	*Width of groove (mm)*	*Depth of Groove (mm)*	*MB mean width (mm)*	*Reference*
Alaska and Yukon Territory								
Trail Creek Cave 2	7	Antler	121 x 8 x 6	Bilateral (I cross section)	1.5-2.0	3.0	8.0	Larsen 1968
Ilnuk	1	Bone	23 x 6	Unilateral	2.0	2.0	?	Ackerman 1996b:468-469
Lime Hills Cave I (10000 BP)	1	Bone or antler	107 x 5-7 x 4-6	Bilateral (S cross section)	?	3.8	5.6 (n=1)	Ackerman 1996a
Gladstone Ice Patch (JhVl-1) (7100 BP)	1	Antler	246 x 10 x 10	Bilateral	?	?	NA	Hare et al. 2004
Rice Ridge (6000 BP)	14	Sea mammal bone or antler	>280 x 9-12 x 4-8	Bilateral (I cross section)	1.9±0.5 (range 0.7-2.4)	3.0±1.0 (range 1.5-3.7)	7.8 (n=10)	Steffian et al. 2002
Siberia								
Zhokov Island (8000 BP)	25	14 bone, 7 antler, 3 fossil mammoth ivory, 1 walrus ivory	240-368 x 24-25 x 8-15	Unilateral, bilateral	1.5-2.0	range 3.0-5.0	7.0-9.0	Pitul'ko 1993; Giria and Pitul'ko 1994
Kokorevo I (13000 BP?)	2	Bone	110 x 16	Unilateral	1-2	3	4 (n=6)	Abramova 1979; Abramova 1967, cited in Powers 1983:113
Afontova Gora II (21000 BP)	2	Bone	145 x 15-21 x 1	Unilateral	?	?	?	Abramova 1979; Derev'anko and Markin 1998:Fig. 87
Afontova Gora III	1			Unilateral	?	?	(n=3)	Abramova 1967, cited in Powers 1983:114
Chernooz'or'ye Cultural Horizon I (10-11000 BP)	2	Bone	387 x 13 x 12	Bilateral (I cross-section)	?	?	3.5-6.0	Petrin 1974, cited in Derev'anko and Markin 1998:80-82, Fig. 40
Lugovskoya (Mammoth vertebra impression of javelin/spear point) (13500 BP)	1	?	24 x 7-9	Bilateral (I cross section)	?	?	7.0 (n=1)	Zenin et al. 2003

Table 8.10 Continued.

Verkholenskaya Gora I (12600 BP)	1	Antler	56 x 15 x 8	Bilateral	?	?	present	Aksenov 1969:85
Kurla III early complex (24000 BP?)	1	Bone	Cannot be measured (no scale provided) (thickness is 44% of width)	Bilateral (I cross section)	?	?	present	Medvedev 1998:132
Stud'onoe I Layers 16-18 (11600 BP)	1	Bone (rib)	268 mm long	Unilateral	?	?	?	Konstantinov 1994, cited in Vasil'ev 2001:21; Kirillov and Derev'anko 1998:147
Stud'onoe I Layers 10-12 (12500 BP)	1	?	?	Bilateral	?	?	?	Kirillov and Derev'anko 1998:147

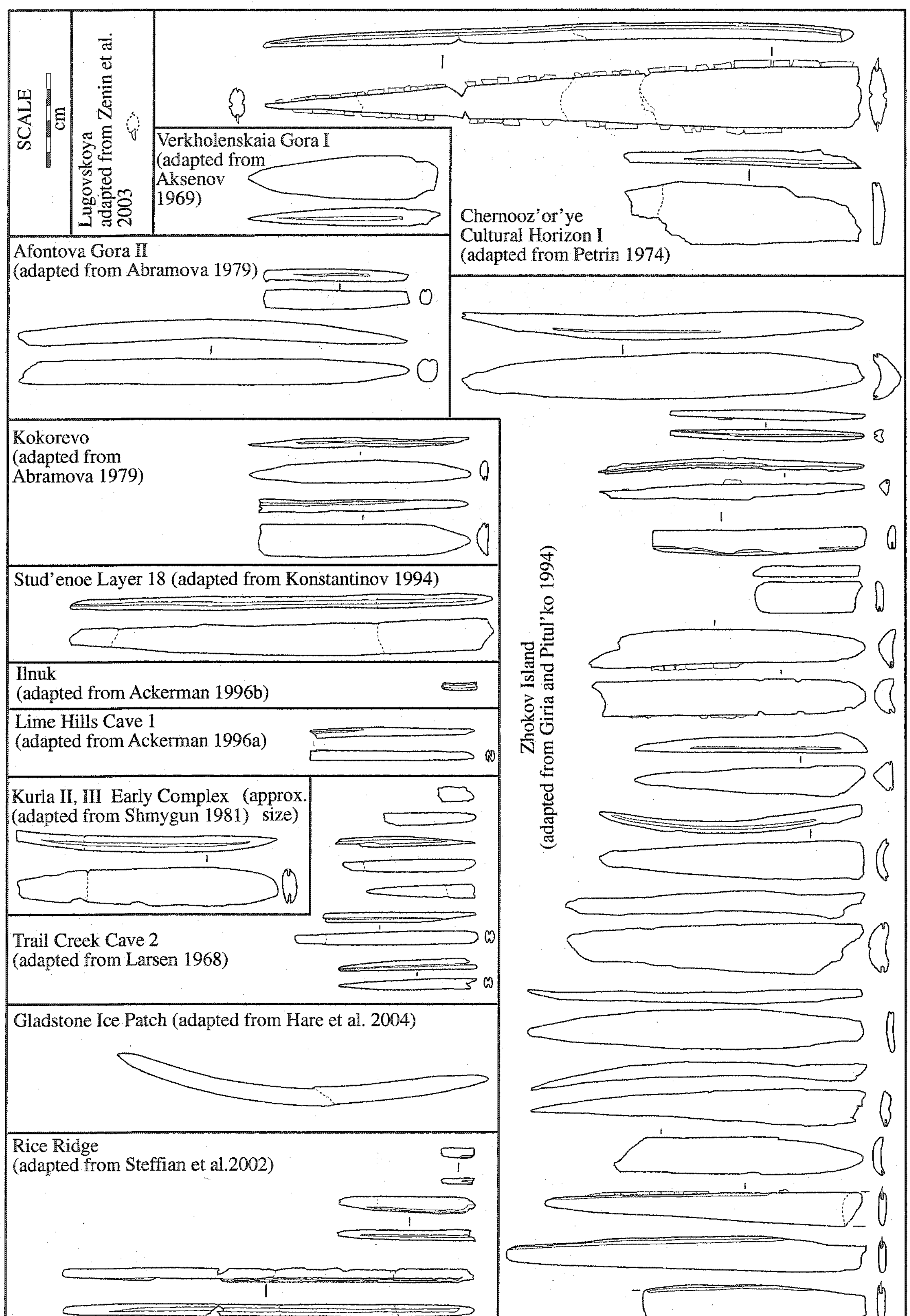


Figure 8.10 Alaskan and Siberian slotted implement outlines and cross-sections.

This might suggest that the mammoth ivory point found in Component 3 (238 mm long by 7-9 mm wide) may have been a preform for such a composite point that was discarded prior to engraving lateral slot(s), perhaps due to the breakage at the tip (see Figure 7.59).

Function of these slotted tools is difficult to ascertain on the basis of the limited samples available at present, however base form of the Trail Creek Cave point is beveled suggesting it was affixed to a shaft of a dart (Larsen 1968:54). The base forms at Rice Ridge and Gladstone Ice Patch are tapered (the latter characterized as a flattened tang). The base of the latter specimen is "heavily scored, probably to facilitate hafting with sinew ties" (Hare et al. 2004:264). Interpretations of slotted composite tools as dart projectile points is likely. However, data from Zhokov Island in Siberia and other sites suggest that composite tools may have served other functions (Pitul'ko 1993; Giria and Pitul'ko 1994). These authors delineate two different types, (1) large bilaterally grooved spear points (up to 368 mm long) and (2) unilaterally grooved tools that may have functioned as spear points, projectile points, or knives (Giria and Pitul'ko 1994:32-33). Interestingly, a wider range of materials were used to construct the tools, including fossil mammoth ivory. This further suggests that the mammoth ivory point may have been a preform for a composite point. The specimen at Chernooz'or'ye Cultural Horizon I is interpreted by Derev'anko and Markin to be a dagger blade (1998:81). Taken as a whole, the Alaskan and Siberian data suggests that composite tools likely had a number of different functions, including spear points, knives (daggers), and dart projectile points.

Comparisons with Dry Creek Components 1 and 2

The largest excavated microblade component in Interior Alaska is Dry Creek Component 2 (Powers et al. 1983). As noted above (cf. Potter 2000, 2004b), microblade technology is present in five of the fourteen artifact clusters at Dry Creek Component 2 (Hoffecker 1983a, b) (see Figure 8.11). While distinction was made between these two basic cluster types (Hoffecker 1983a:203), no discrimination was made within the microblade clusters. In fact, there are considerable differences in tool class covariation and flake sizes.

Hierarchical cluster analyses were used to classify assemblages into groups based on a co-similarity matrix, using the Ward method and squared binary Euclidean measure for presence-absence tool class data for Components 1 and 2 at Dry Creek. Tool classes were derived from Hoffecker's spatial analysis (1983b), and include biface, burin, burin spall, chopping tool, core tool, core-biface, denticulate, flake core, (flake) core/scraper, hammerstone, microblade, microblade core, microblade core tablet, modified flake, percussion tool, projectile point, uniface (scraper), and utilized cobble (see Powers 1983 for descriptions of tool classes not found at Gerstle River, such as (flake) core-scraper).

When clustered at the component level, as expected, the components with microblade technology were clearly differentiated from those without (Figure 8.12). Gerstle River Components 2 and 3 were more similar to each other than to Dry Creek Component 2, but all three were dissimilar to Gerstle River Components 1, 4, and Dry Creek Component 1.

When clustered at the artifact concentration (i.e., cluster for Dry Creek and Area for Gerstle River), an entirely different pattern is produced (Figure 8.13). Six groups were produced, the most divergent clusters include Groups 1, 2, and 3, with microblades, microblade cores, and burins, and Group 4, 5, 6, and 7, without these tool classes. Table 8.11 lists the tool classes and percent occurrence within each group. Within the microblade groups, Group 1 contains microblades, and high percentages of burins and modified flakes. Group 2 contains bifaces, burins, flake core-scrapers, denticulates, microblades, microblade cores, modified flakes, and half contain utilized cobbles. Group 3 contains bifaces, burin spalls, chopping tools, microblade core tablets, hammerstones, microblades, microblade cores, modified flakes, and unifaces. The primary difference between these groups is the variable presence of bifaces, burin spalls, chopping tools, core-scrapers, denticulates, and unifaces. When considering the actual quantities of tools, the differences between these groups are strengthened. Of the 26 microblade cores found within clusters at Dry Creek C2, 20 of them were from Clusters C and G (Group 2), and only 6 were found within Clusters A, B, and N (Group 1, with 1-3 per cluster). Group 1 clusters at the Gerstle River site, Areas A, C, E, and H, contain no microblade cores. Relatively few other tools are found in Group 1, generally a few burins and modified flakes, and no bifaces or hammerstones were found in any of the Group 1 clusters at either site. Group 2 clusters (Dry Creek Clusters C and G) are very different, with bifaces, burins, flake core scrapers, and denticulates, suggesting multiple tasks. No Group 2 clusters are found at Gerstle River. Group 3 is made up of Gerstle River Areas B and D, with more microblade cores and core fragments than the other Gerstle River Areas, but also with bifaces, burins, burin spalls, spall scrapers, and hammerstones.

The groups without microblades were distinguished by different tool classes. Group 5 contained 100% occurrence of bifaces, flake cores, flake core scrapers, and modified flakes and

Group 6 contained 100% occurrence of flake cores, percussion tools and unifaces (scrapers). Group 4 did not contain 100% of any one tool class, though they were the only clusters to contain any projectile points (found at 55% of these clusters). With the seven cluster solution, Group 4 is divided into two groups, one (n=7) with high occurrence of bifaces (86%) and projectile points (57%), and the other (n=4) with a high occurrence of modified flakes (75%) and a low occurrence of bifaces and projectile points (5% each).

In order to examine the microblade groups at Dry Creek more closely, I plotted length and width of the samples for each cluster presented in Hoffecker (1983a, b) by group based on the hierarchical cluster analysis. Figure 8.14 shows flake width for Groups 1 and 2 at Dry Creek and comparison with maximum dimensions of flakes at Gerstle River Components 2 and 3. Group 2 clusters at Dry Creek clearly have relatively more size class 4 and 5 flakes (15-25 mm) than Group 1 clusters. When the means for these two groups are compared with Components 2 and 3 flake maximum dimensions at Gerstle River, the latter are even more peaked, with relatively more size class 2 flakes (5-10 mm) than any of the groups at Dry Creek.

Two explanations can be offered to explain these patterns. First, the presence of other tool types in Group 2 could explain larger flakes if those tools (bifaces, etc.) were manufactured at that location. However, the presence of bifaces, unifaces, and other tool classes at Gerstle River Component 3 is not associated with larger flakes. In addition, microblade technology dominates all of the Dry Creek clusters in Groups 1 and 2. A second explanation is that these groups reflect microblade core production in Group 2 (where 77% of Dry Creek Component 2 cores were recovered) and microblade core maintenance in Group 1 (where 23% of the cores were recovered). The absence of microblade core tablets in Group 2 and their variable presence in Group 1 suggests that core platform rejuvenation occurred at a later stage in the core reduction process. If cores were being manufactured in Group 2, it might explain the larger flake sizes. The lack of larger flakes in Gerstle River Components 2 and 3 add support to the hypothesis that cores were not being manufactured there, but rather were brought in, microblade production (along with platform rejuvenation) occurred, and they were generally taken from the site. While this may indicate that Gerstle River Components 2 and 3 reflect shorter duration of occupations than Dry Creek Component 2, the much larger size of the assemblage at the latter suggests that more occupations may be present at Dry Creek Component 2.

The relative lack of microblade cores at Gerstle River could be due to a location further away from high quality raw material sources than Dry Creek. This appears to be reflected in the small flake sizes and raw material diversity at the former site in Components 2 and 3. If this were the case, the relative lack of microblade cores at Gerstle River may be due to curation. Dry Creek Component 2 contains 1772 microblades and 21-microblade cores, compared with Gerstle River Component 3 with 1350 and 2 microblade cores (84 and 675 microblades/core respectively). This difference may relate to availability of high quality raw materials. If the exhausted microblade core found in disturbed contexts relates to Component 3 (considered likely, given the light blue-gray variety of gray chert found in that component), this would give further support to high curation at that component.

In order to see how the tool classes are related, I conducted another hierarchical cluster analysis clustering variables (tool classes) instead of cases (artifact concentrations). The results are provided in Figure 8.15. A number of important patterns emerge from this analysis. The greatest differentiation is between the microblade group, consisting of (a) microblades, microblade cores, burins, and modified flakes, and (b) all other tool classes. While the microblades and microblade cores relationships are direct, there is no *a priori* reason burins or modified flakes should co-occur with them. The close clustering of burins and microblade technology exhibited here allows for a hypothesis that a specific toolkit relating to microblade technology includes burins. The clustering of modified flakes within the microblade group is interesting, and may reflect both expedient and formal tool manufacture within a single systemic context.

Interestingly, burin spalls cluster more with unifaces than with burins, which may suggest that at least some burin spalls may be associated with a specific rejuvenation or resharpening technique for unifaces. Projectile points and other bifaces are clustered, suggesting that some of these artifact concentrations represent a chain of operation from biface reduction to projectile point manufacture or concurrent use for certain tasks. It may also suggest that archaeologists do not yet have sufficient data to discriminate bifaces used as projectile points and bifaces used for other tasks (or for multiple tasks).

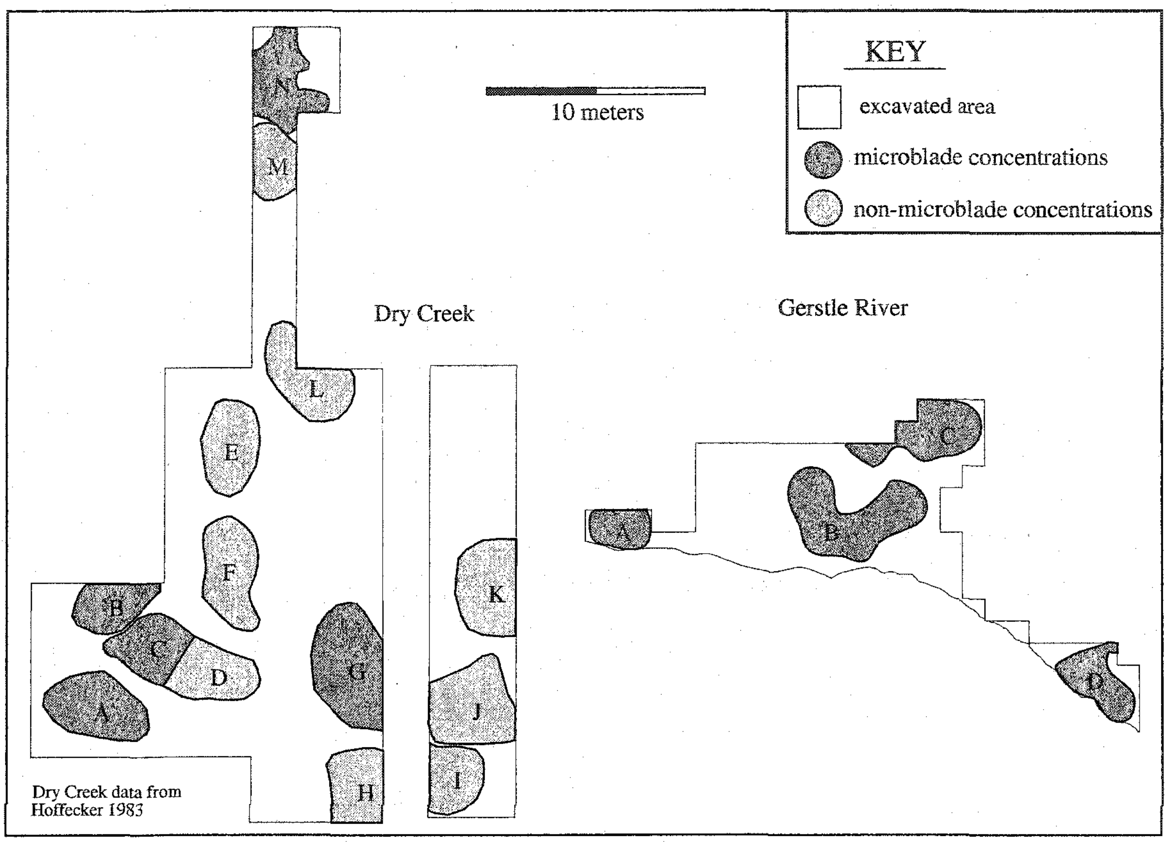


Figure 8.11 Gerstle River Component 3 lithic areas and Dry Creek Component 2 lithic clusters.

Table 8.11 Tool class percent occurrence in Gerstle River and Dry Creek groups.

Tool Class	*Group 1*	*Group 2*	*Group 3*	*Group 4*	*Group 5*	*Group 6*
N	7	2	2	11	2	2
Biface		100	100	73	100	
Burin	86	100	50	9		
Burin spall	43		100	27		
Chopping tool (+spall scrapers)	14		100	18	50	
Flake core					100	100
Flake core-scraper	14	100			100	
Microblade core tablet	43		100			
Core tool				9		
Core-biface						50
Denticulate		100				
Hammerstone			100	9		
Microblade	100	100	100		50	
Microblade core	43	100	100			
Modified flake	86	100	100	45	100	
Percussion tool				9		100
Projectile point				55		
Uniface (scraper)			100	36	50	100
Utilized cobble		50		9		

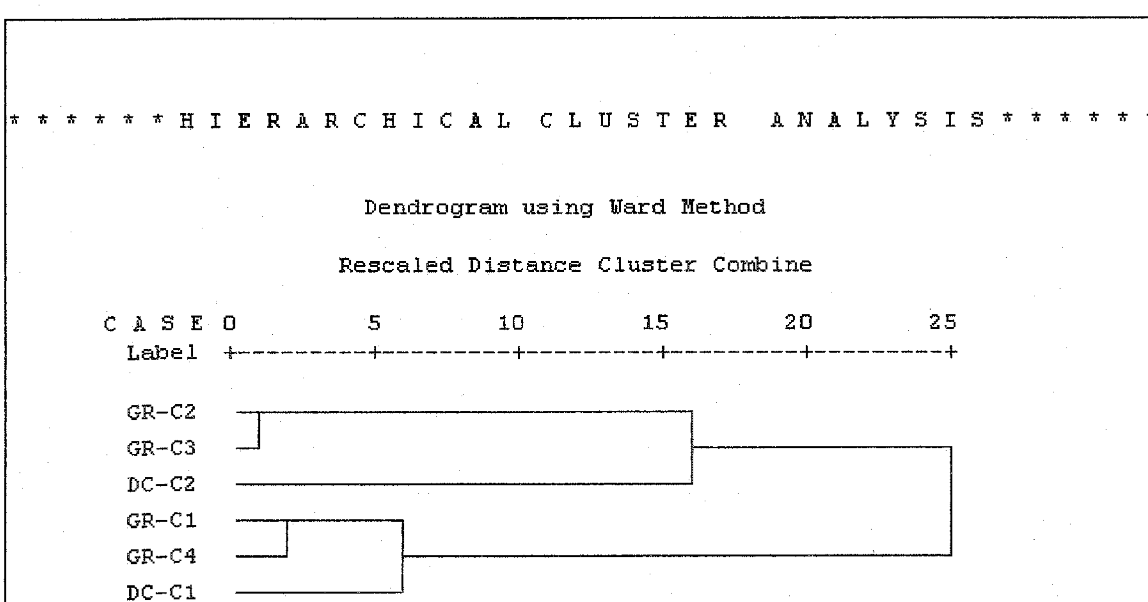


Figure 8.12 Hierarchical cluster results of Gerstle River and Dry Creek components.

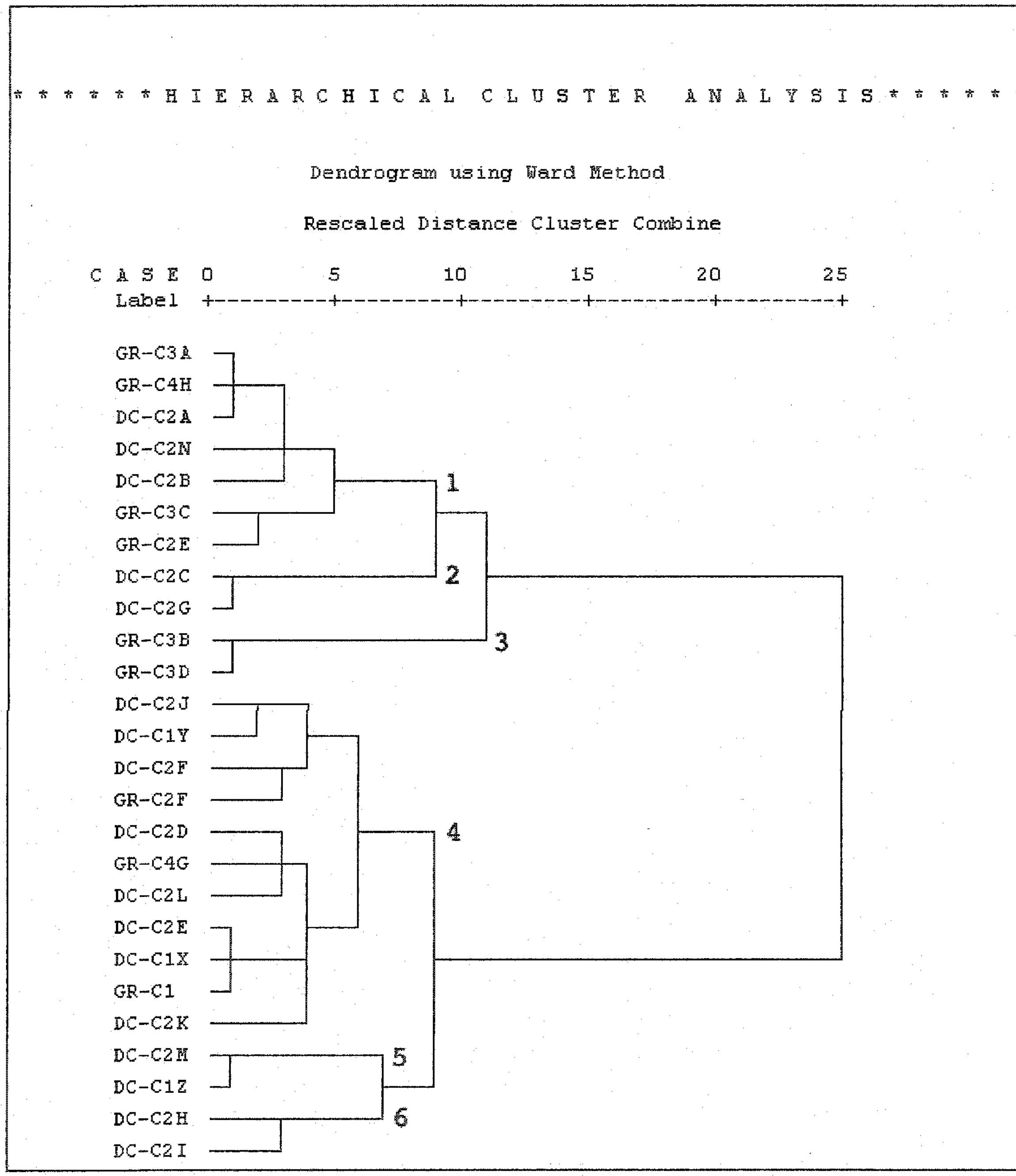


Figure 8.13 Hierarchical cluster results of Gerstle River and Dry Creek lithic concentrations.

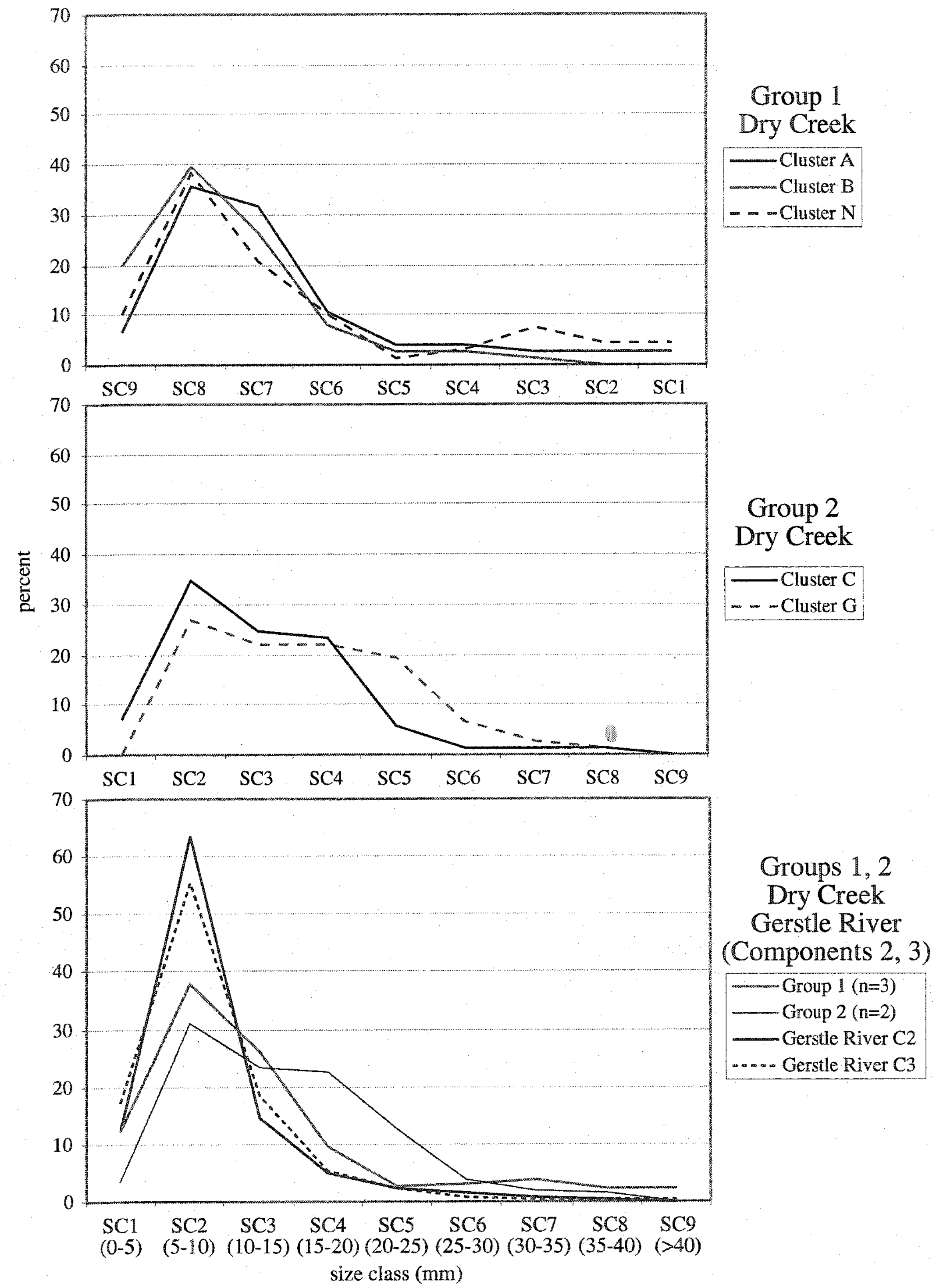


Figure 8.14 Flake size class percentages at Dry Creek (flake width) and Gerstle River (maximum dimension) microblade clusters.

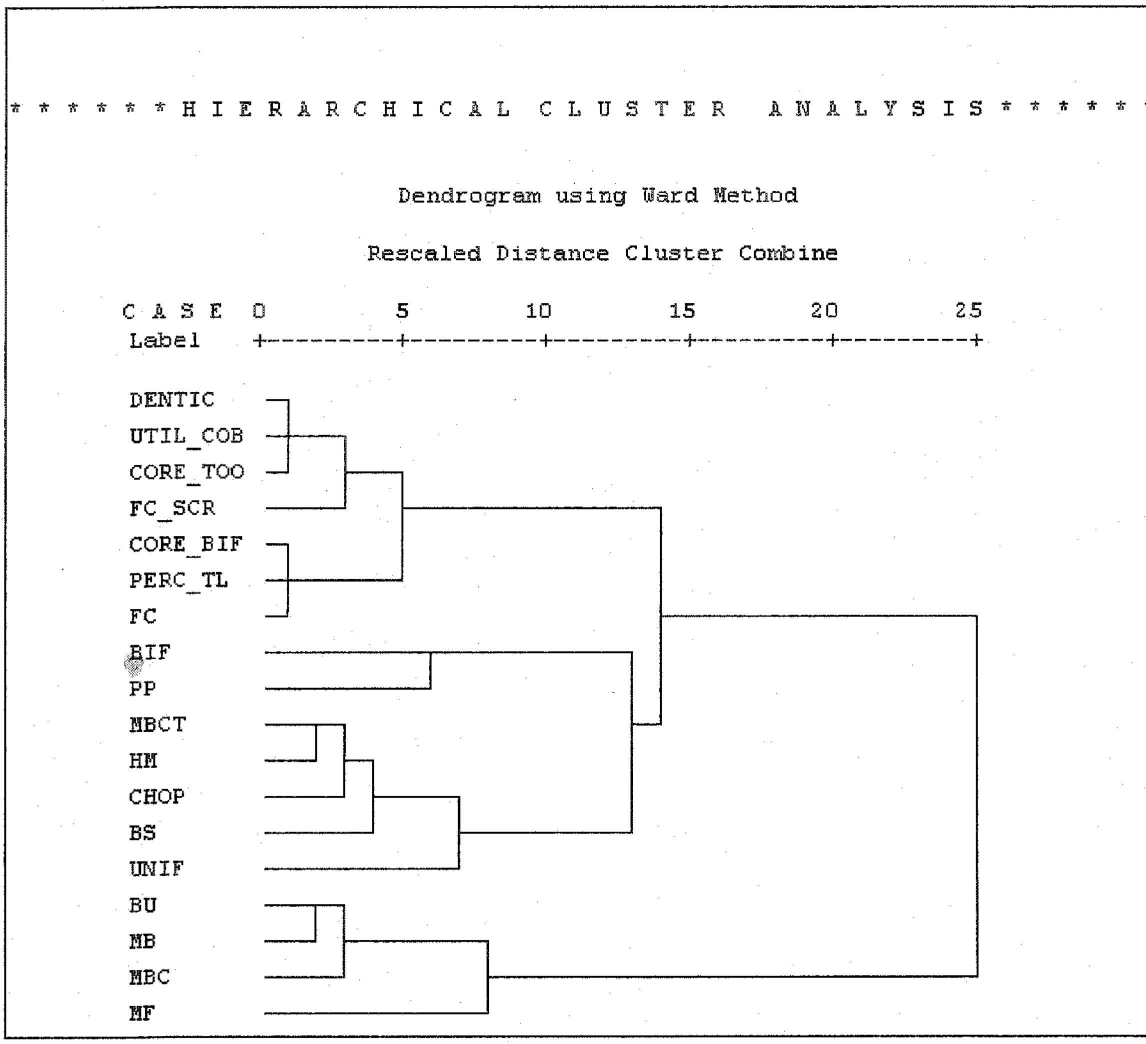


Figure 8.15 Hierarchical cluster results for implement classes (from top to bottom: denticulate, utilized cobble, core tool, (flake) core scraper, core biface, percussion tool, flake core, biface, projectile point, microblade core tablet, hammerstone, chopper, burin spall, uniface, burin, microblade, microblade core, and modified flake).

Temporal Distribution of Microblade Technology in Interior Alaska

As a prolegomena to a discussion on microblade function, it is pertinent to review the actual temporal distribution of microblades in Interior Alaska. Microblade technology has been used as temporal diagnostics to discriminate assemblages (Dixon 1985; Powers and Hoffecker 1989). The record does not support this demarcation. For the 135 dated components within the Tanana, Nenana, Tangle Lakes, Copper River, and Upper Susitna areas, 45 contained microblade technology (33%) (Potter 2000). Microblade technology has a continuous distribution from the earliest components (Swan Point Cultural Zone 4a and 4b) to some of the latest (Swan Point CZ 1, Healy Lake Village Athabaskan, Healy Lake Garden, Dixthada C1, Broken Mammoth CZ1a, and Owl Knoll). With the recent re-evaluation of Ushki Lake sites 1 and 5 (Goebel et al. 2003), the oldest unequivocally dated component in Beringia is now Swan Point CZ 4b, with an age estimate of 12071±51 BP (average of four dates) with associated wedge shaped microblade core, microblades, core tablets, and dihedral burins (Crass and Holmes 2003; see also Holmes 1998b; Holmes et al. 1996).

A number of archaeologists have commented on an apparent pattern exhibited by early prehistoric components in the Nenana Basin, with non-microblade components dating to 11500-11000 BP period and microblade components dating to 11000-10000 BP period (Powers and Hoffecker 1989; Goebel et al. 1991; Hoffecker et al. 1993). Recently, other authors have defined Broken Mammoth and Swan Point Cultural Zones 3 as "Nenana assemblage[s] with a Denali age" (Bever 2001b:161). Yesner and Pearson (2001) consider Broken Mammoth CZ4, Mead CZ4, and remarkably Swan Point CZ4 as part of the Nenana Complex, though Holmes (2001:165) has proposed subsuming all Nenana and Denali sites under a single East Beringian Tradition. It should be noted that the lithic tool assemblage from the lowest cultural zones at Broken Mammoth and Mead are meager (Holmes 2003, personal communication).

When the archaeological record is examined critically, a chronologically distinct non-microblade tradition followed by a microblade tradition is not substantiated in the context of all components dated between 12000 and 7000 BP in Interior Alaska. Of the 41 dated components in the Tanana Basin (including the Nenana Basin), half (n=18) contain microblades and half do not. A table of these components and actual and expected values assuming equal representation per millenium BP is provided below (Tables 8.12 and 8.13).

Table 8.12 All dated components in the Tanana Basin between 7000-12000 BP[1].

Component	*Average age (BP)*	*Notes*	*Micro-blades*	*Fauna*	*Reference*
Swan Point CZ4b	12070	average of 4 dates	Yes	Yes	Crass and Holmes 2003
Swan Point CZ4a	11660	average of 2 dates	Yes	Yes	Holmes et al. 1996
Mead CZ4	11580	average of 2 dates	No	Yes	Holmes 1999, personal comm.
Broken Mammoth CZ4	11540	CZ4b-c average of 7 dates	No	Yes	Holmes 1996
Owl Ridge C1	11340		No	No	Phippen 1988
Moose Creek C1	11190		No	No	Pearson 1999a
Walker Road C1	11160	average of 3 dates	No	Yes	Goebel et al. 1996
Dry Creek C1	11120		No	Yes	Powers et al. 1983
Moose Creek C2	10500		Yes	No	Pearson 1999a
Mead CZ3	10430	average of 2 dates	No	Yes	Dilley 1998
Broken Mammoth CZ3	10280	average of 2 dates	No	Yes	Holmes 1996
Phipps Site	10230		Yes	No	West et al. 1996a
Swan Point CZ3	10230		Yes	Yes	Holmes et al. 1996
Whitmore Ridge C1	10160	average of 4 dates	Yes	No	West et al. 1996c
Chugwater C1	10000	estimated (greater than 9460 BP)	No	No	Lively 1996
Little Delta River Site 3 (XBD-167)	9920		No	No	Higgs et al. 1999
Healy Lake Village Chindadn (XBD-020 Levels 6-10)	9870	average of 16 dates	Yes	Yes	Cook 1996
Panguingue Creek C1	9840	average of 2 dates	No	No	Powers and Maxwell 1986
Gerstle River C1	9740		No	Yes	This dissertation
Dry Creek C2	9690	average of 9 dates	Yes	Yes	Powers et al. 1983
Jay Creek Ridge C1	9510	average of 4 dates	No	Yes	Dixon 1999
Chugwater C2	9460		Yes	No	Lively 1996
Gerstle River C2	9450	average of 2 dates	Yes	Yes	This dissertation
Sparks Point	9120	average of 3 dates	Yes	No	West et al. 1996b
Delta River Overlook C1	9000	estimated (greater than 8555 BP)	Yes	Yes	Bacon and Holmes 1980
Gerstle River C3	8880	average of 13 dates	Yes	Yes	This dissertation
Gerstle River C4	8660		Yes	Yes	This dissertation
Erodeaway	8640		No	Yes	Holmes 1988
Carlo Creek C1	8550	average of 2 dates	No	Yes	Bowers 1980
Owl Ridge C2	8090	average of 4 dates	No	No	Phippen 1988
Gerstle River C5	7970		No	Yes	This dissertation
Houdini Creek	7880		No	No	Bowers et al. 1995
Panguingue Creek C2	7800	average of 6 dates	Yes	Yes	Powers and Maxwell 1986
Broken Mammoth CZ2	7500	average of 3 dates	Yes	Yes	Holmes 1996
Swan Point CZ2	7400		Yes	Yes	Holmes et al. 1996
Teklanika West C1	7130		Yes	Yes	Goebel 1996
Owl Ridge C3	7040		No	No	Phippen 1988

[1] All components in the Tanana Basin except Jay Creek Ridge, located in the Susitna Basin (Dixon 1999).

Table 8.13 Components older than 7000 BP in the Tanana Basin.

Millennia	*MB Components Actual*	*Non-MB Components Actual*	*MB Components Expected*	*Non-MB Components Expected*
12000-11000 BP	2	6	3.9	4.1
11000-10000 BP	4	3	3.4	3.6
10000-9000 BP	6	4	4.9	5.1
9000-8000 BP	2	3	2.4	2.6
8000-7000 BP	4	3	3.4	3.6
Totals	18	19	18.0	19.0

Deriving meaning from patterns generated from small sample sizes should be done cautiously, and the real possibility of sampling error or sampling bias must be addressed. In order to determine if the apparent pattern of non-microblade component temporal priority over microblade components is statistically significant, I conducted a series of Pearson χ^2 tests on these components (n=37). The Pearson χ^2 tests the hypothesis of no association of columns and rows. It would detect significant deviation of the actual values relative to the expected values calculated by multiplying the row and column totals and dividing by the grand total. Therefore, it tests the null hypothesis that the row (time period) is unrelated (randomly related) to the column variables (microblade and non-microblade components). Because a number of the cells have values of less than 5, Yates continuity correction was applied for the last series (2 x 2 table).

When components in all millennia are examined (n=37), the test fails at α=0.05 (χ^2=2.86, df=4, p=0.581). When only the period between 9000-12000 BP is examined (n=25 components), the test also fails (χ^2=2.51, df=2, p=0.286). When only the first two millennia are examined, 12000-10000 BP (n=15 components), the test also fails (χ^2=1.61, df=1, p>0.205). The Yates χ^2 test (with continuity correction) also fails (χ^2=0.547, p=0.460). Fisher's Exact Test yields a p value of 0.196. The ϕ^2 is the proportion of variance in one variable explained by the variance in the other variable, and the resulting value for the 10000-12000 BP data is 0.107, relatively small. It should be noted that the test designed above is conservative, as only one component was defined for Healy Lake Village Chindadn (Levels 6-10, with associated dates between 8210±155 BP and 11410±60 BP [Cook 1969; Erlandson et al. 1991]) and Dry Creek Component 2 which probably has multiple occupations between 7985±105 BP and 10690±250 BP. Furthermore, Mead CZ4 has received only limited testing, and the tool assemblage for Broken Mammoth CZ4 is limited. Others have argued that multiple components are likely based on the spatial distribution of artifacts and radiocarbon dating at these sites (e.g., Mason et al. 2001).

The apparent pattern of microblade and non-microblade component time differences is not substantiated. The most parsimonious conclusion is that this apparent pattern merely reflects sampling error. The hypothesis that microblade occurrence within sites in this region is related to site structure, activity areas, or other functional facies rather than cultural groups with and without microblade technology is not refuted. The hypothesis that microblade technology is tied with certain cultural groups that are distinct in time and space is not supported by these results. Certainly the extreme view that non-microblade-using populations absolutely preceded microblade-using groups is refuted.

From an intersite technological viewpoint, a number of archaeologists have defined non-microblade components as Denali Tradition on the basis of various bifacial and other forms, such as Carlo Creek Component 1 (Bowers 1980:176), Houdini Creek (Bowers et al. 1995), Jay Creek Ridge (Dixon 1985:54), and Panguingue Creek Component 1 (Goebel and Bigelow 1992:16). However, other non-microblade components have been assigned to the Denali Complex on the basis of age alone, such as Owl Ridge Component 2 (Phippen 1988:137-138), Eroadaway, and Jay Creek Ridge (Mason et al. 2001). Other authors have considered Panguingue Creek C1, Carlo Creek C1, Eroadaway, and Jay Creek Ridge to be Northern Paleoindian manifestations, mainly given the lack of microblades (e.g., Dixon 1999:182). Defining traditions or assigning assemblages to cultural traditions on the basis of presence/absence of microblade technology or age alone seems untenable.

The continuous temporal distribution of microblade technology in Alaska has been viewed by some archaeologists as a form of technological conservatism (Holmes and Bacon 1982). Many tool classes and types are relatively unchanged from Late Pleistocene to Late Holocene, such as wedge shaped microblade cores (Holmes et al. 1996; Bowers 1999), flake burins, short-axis beveled flakes (aka, thumbnail end scrapers), lanceolate bifaces, and spall scrapers. Given these patterns, it seems prudent to proceed in a different fashion than standard typological approaches in order to understand intersite variability in this region.

Since microblade technology clusters within sites for which large excavation areas are available (e.g., Dry Creek, Healy Lake Village) and sites with and without microblades are coterminous within the same region, microblade use is likely conditioned by site organizational and technological organizational factors. These factors may include task scheduling, seasonality, resource acquisition, and/or settlement system. I argue that microblade technology formed a subset within technological systems derived from Late Upper Paleolithic complexes in Siberia.

Almost the entire range of tool classes present in Siberia after the Late Glacial Maximum is present in early Alaskan industries, including bifacial knives, projectile points, cores, various beveled (unifacial) flakes and blades, microblade technology, and various burin types. The variability in how these tool class sub-sets are deposited within Interior Alaskan sites at the terminal Pleistocene and earliest Holocene may have more to do with technological organization rather than reflecting different cultural and demic groups.

These data point to two conclusions. First, the use of microblade technology as a temporal diagnostic is unwarranted. Second, microblade and non-microblade artifact clusters co-occur in time, and in some cases within a single component. Therefore, I argue that archaeologists must address microblade technology in a more sophisticated way. I suggest that assemblage variability can be explored more profitably by cluster analysis and significance testing based on large samples and explicit aggregation protocols (Potter 2000, 2004b). A critical re-evaluation of our current models for cultural continuity and change in Interior Alaska is needed. In this analysis, we should understand the constraints of small sample sizes for each time period. Detailed intersite variability analysis is beyond the scope of this dissertation, but microblade use within Gerstle River is examined within systemic contexts below.

Microblade Function at Gerstle River

Patterns of Microblade Function

A number of paradigms exist regarding the functions of microblades in prehistoric economies. Most researchers hypothesize that microblades in Beringia were primarily or exclusively used as side insets into composite organic (antler, bone, or ivory) armatures that were presumed to function as projectile tips (Larsen 1968; Guthrie 1983b, 1983c; Ackerman 1996a; Hare et al. 2004). As seen above, a number of grooved implements have been found with and without associated microblades, however very little empirical data is available for variability in different times and in different technological complexes. A survey of the recent literature shows that material types were quite variable, including fossil mammoth ivory, modern walrus ivory, antler, and bone, though antler seems to be the predominant form in Eastern Beringia. Morphology of the slotted implements varies as well, from elongate thin points to wide blades, and data from the largest sample to date (Zhokov Island) suggests multiple forms were common.

Other functions have been suggested for these lateral insets, such as knives or daggers (Abramova 1979; Derev'anko and Markin 1998:81; Giria and Pitul'ko 1994:32-33), spear points (Giria and Pitul'ko 1994), arrow points (Ackerman 1996b:469; Dixon 1999), gravers or awls (Sanger 1968; Ackerman 1985), and/or saws or shredders (Yi and Clark 1985:17). Cook (1968) suggests that microblades may be byproducts from use of cores themselves as tools, citing crushing on platform margins and the low frequency of retouched microblades in the interior.

Certainly, some of these ascribed functions can be assessed given present data. Recent work in the Yukon Territory ice patches has resulted in a dated sequence of dart and spear thrower (atl atl) and bow and arrow technologies (Hare et al. 2004; Farnell et al. 2004). A clear pattern of dart use from at least 8400 BP to 1250 BP, where it was abruptly replaced by bow and arrow technology (Hare et al. 2004:268). This suggests that composite point and bifacial point armatures interpreted to be projectile points were hafted to darts that were thrown with the aid of a spear thrower rather than arrow points.

Potential measurements and observations relating to modified microblades are influenced by the issue of microblade function in Eastern Beringia, for which very little empirical data is available. Only five sites in this region have associated slotted organic points or fragments, seven from Trail Creek Caves, Cave 2 (Larsen 1968), one from Lime Hills I (Ackerman 1996a), one from Ilnuk (Ackerman 1996b), eleven from Rice Ridge (Steffian et al. 2002), and one from Gladstone Ice Patch (Hare et al. 2004) (see below).

Microblade morphology can yield clues as to possible functions, or at least use limitations. Compared with other blank forms (large flakes, bifaces, cobbles, etc.), they are brittle and easy to break with transverse or perpendicular motion to the long axis. They are sharp, but they dull easily, and are therefore more suited for cutting relatively soft materials such as flesh and hide. Other potential non-piercing functions could be slicing, sawing, or shredding. The Gerstle River microblades, and Interior Alaskan microblades in general, do not exhibit extensive damage and relatively few have intentional retouch or usewear (Owen 1988:72, 398). This suggests motion parallel to the long axis of the microblade, making use of the fine cutting edge.

Microblades themselves have not seen the type of taxonomic discrimination given to microblade cores, other than retouched or unretouched, but some studies have examined technological characteristics to discriminate different types. Elston and Brantingham (2002) differentiate between production and maintenance microblades, the latter used to prepare the core fluting face and platform for detachment of the former, which were snapped and used as insets in composite tools. Elston (2004, personal communication) suggests that qualitative observations about suitability can discriminate the two, essentially minimal ventral and lateral curvature, parallel sides, and usewear or retouch. This study suggests that more complicated relationships exist among discrete and continuous microblade variables with respect to modification and use.

The presence of microblades with various retouch or usewear locations at Gerstle River suggests multiple uses. End modified microblades may have been used as borers, perforators, or engravers. Although microblade production has often been seen as a process to achieve one specific end tool form or blank, these data suggest that microblades formed blanks for a number of different uses within a number of different hafts. Given the small size of microblades, they would require hafting of some sort in order to result in usewear on the distal end.

Based on the morphological and technological data presented above and in Chapter 7, I hypothesize that two main types of tools were made using microblade blanks. The first type were composite points with microblades as side blade insets, used in a manner consistent with cutting, slicing, or penetrating (i.e., knife, spear point, or projectile (dart) point). The second type were composite tools where a single microblade was inset and used as for piercing or perforating soft materials (perhaps associated with clothing manufacture or repair).

Different microblade attributes were important for blank selection for both of these tool types. For end modified microblades, relatively low coefficients of variation in length and modified weight suggests these factors were important in blank selection. End modified microblades were longer, wider, thicker, and heavier than unmodified microblades, and longer and thicker than laterally modified microblades. End modified microblades were evenly represented on proximal, medial, and distal segments, and outline variability suggests that these items were used singly rather than in conjunction with other microblades (e.g., end to end in a row) (see Figure 7.29). For laterally retouched microblades, proximal width and thickness were the principal selection factors. Laterally modified microblades were wider, thicker, and heavier than unmodified microblades. Laterally modified flakes were much more likely to be medial segments (56-74%).

Models of Microblade Function in Interior Alaskan Technological Systems

A number of hypotheses are presented below and assessed with the extant archaeological data in the literature and data presented in Chapter 7 and above. For the context of this discussion, it should be noted that a number of different projectile or non-projectile point forms are present in the Alaskan archaeological record, including bifacial points, non-slotted organic points, and slate points. The models include association of microblade technology (1a) at a cultural or demic level temporally distinct from non-microblade assemblages, (1b) with a function similar to bifacial projectile points but used in mutually exclusive technological systems, (2) dual systems reflecting differential access to high quality lithic raw materials, (3) with a specific prey species, and (4) with a function distinct and separate from bifacial projectile points.

Similar Function: Cultural, Demic, or Temporal Differences

The first model considered is that microblades represent distinct cultures or populations (Dumond 1969; West 1981; Yesner and Pearson 2002). The necessity for a projectile point could be fulfilled by composite points in one group and bifacial points in another group. However, many microblade components have associated bifacial projectile points. Another aspect of this model is that microblades represent cultural or demographic groups distinct from coterminous non-microblade populations. However, the co-occurrence of microblade and non-microblade components within the same region throughout the entirety of the Alaskan archaeological record indicates this is not the case (see above).

Another aspect to this model is that microblades may represent an influx of technology into Interior Alaska that is demarcated in time. Some archaeologists suggest that microblades represent a later occupation in Interior Alaska (termed "Denali"[2]) after an earlier non-microblade occupation (termed "Nenana") (Powers and Hoffecker 1989; Goebel et al. 1991; Hoffecker et al. 1993). However, the analysis above has shown that in fact we cannot distinguish the apparent prevalence of non-microblade components from 12000-11000 BP from a sampling error. In any event, the presence of two components with microblade technology at Swan Point at ca. 12100 BP and ca. 11700 BP (Crass and Holmes 2003) refutes this model.

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[2] Denali is normally termed a "complex" (i.e., techno-complex composed of recurring types), however it should be viewed as a tradition given the normal usage of these terms (*sensu* Willey and Phillips 1958).

Similar Function: Differential Access to Lithic Raw Materials

Since bifacial projectile points and bifacial knives co-occur with microblade technology, there may be some other difference that would necessitate two coterminous types of weapons platforms. The composite and bifacial points may have functioned as dual systems based on seasonality, with bifacial forms used in periods where lithic raw material was not at a premium (e.g., summer, or during a period of transiting lithic-rich areas) and composite forms used in periods of lithic scarcity (e.g., winter). To test this model, I examined all prehistoric sites found within 5 km of three known material sources in Interior Alaska, Batza Téna (obsidian Type B) near the Melozitna River (Clark and Clark 1993), Livengood (chert) north of Fairbanks (Derry 1976), and Landmark Gap (chert) in the Tangle Lakes area (West 1981). Ages for components in these areas range through the Holocene, but given the presence of microblades throughout this period, this is warranted.. Figure 8.16 shows the distance for sites with and without microblade technology located at 1 km intervals from the sources. At Batza Téna and Livengood, microblade sites and non-microblade sites show similar patterns, with a sharp increase within 2 km of the sources. Landmark Gap has a total of 91 sites located within 5 km of the source, and only one contains microblade technology. However, the entire Tangle Lakes area has relatively few microblade sites (about 3% of the total), and the difference could be due to the other ecological or topographic variables. Microblade sites were also found in close proximity to the other major interior obsidian source (Type A), in the Wrangell Mountains (Jody Patterson, 1998 personal communication). The percentage of sites within 5 km of lithic raw material sources containing microblade technology is 43% for Batza Téna, 17% for Livengood, and 1% for Landmark Gap. The overall percentage of sites with microblade technology in Interior Alaska is 35%, suggesting that microblade sites are not less likely to be found near lithic quarries. Overall, the spatial distribution of microblade sites suggests composite points were used at the same times and places as bifacial projectile points.

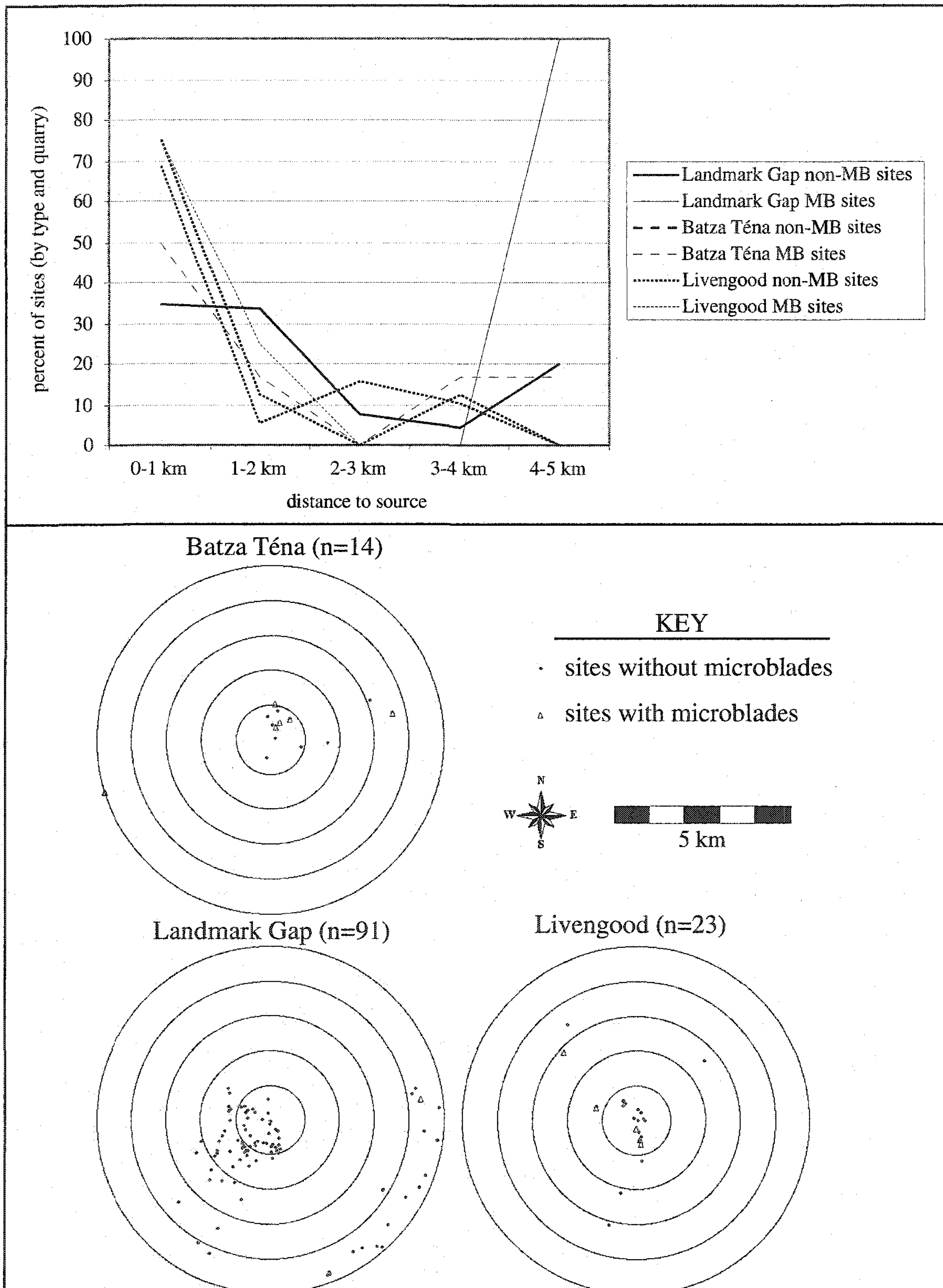


Figure 8.16 Distance to Interior Alaskan lithic raw material sources by microblade technology.

Similar Function: Specific Prey Species

Another alternate model is that composite points may be prey-specific. Guthrie argues that the distribution of microblade technology corresponds to caribou/reindeer (*Rangifer tarandus)* in both America and Asia, and proposes a functional argument of caribou antler as blanks for composite point manufacture (Guthrie 1983c). While the spatial correspondence is interesting, the association of microblade technology with multiple species, including bison, wapiti, caribou, horse, mammoth, sheep, and small mammals indicates that a preference for caribou exploitation was not present. In addition, the prevalence of other materials for constructing composite points, such as ivory and bone, argue against this interpretation.

Holmes and Bacon (1982) propose that bison exploitation was inextricably linked with microblade technology and that the disappearance of microblades (at that time exemplified by the Delta River Overlook site with bison dating to between 4000 and 2300 BP) co-occurred with the disappearance of bison in Alaska (cf. Bacon and Holmes 1980). While dated sites with identifiable faunal remains are rare in Interior Alaska (see Chapter 6), a correspondence of microblade technology and bison exploitation is reflected in the data. In the Nenana Basin, Dry Creek Component 1 and Carlo Creek Component 1 do not contain microblade technology or bison, whereas Dry Creek Component 2 contains both. In the Tanana Basin, Gerstle River Component 3 and Broken Mammoth CZ 2 contain microblades and bison, however microblades are absent at Broken Mammoth CZ 3 and 4, though it should be noted that the sample size of formal tools in the latter cultural zones are small (Holmes 2003, personal communication). In the Upper Susitna Basin, where caribou dominates the faunal record, microblade sites are relatively rare (found at only 23% of the dated components), especially in the period prior to 5000 BP (Dixon et al. 1985). Microblade technology is found in 25 of the 49 dated components in the Tanana Basin (51%) but only 6 of the 30 dated components in the Nenana Basin (23%). Regional ecological differences between the Nenana and Tanana basins may explain the absence of microblades in the Nenana prior to 10500 BP. From a comprehensive review of bison data in Eastern Beringia, Stephenson et al. (2001:143) note that contrary to hypotheses that bison preferred habitats in "windswept areas adjacent to mountainous terrain [Guthrie 1982] ... the distribution of wood bison remains and geographic referents in oral accounts indicate the presence of late Holocene bison in low elevation habitat." A greater abundance of bison in the low-lying areas in the Tanana basin may be correlated with the higher relative frequencies of microblade components. Siberian data also support a link between microblade technology and bison hunting. Bison occurs at Dyuktai Cave VIIa and VIIb along with microblade technology, and a bison scapula was found penetrated by a composite point at Kokorevo II (Abramova 1979). While a perfect correlation is not evident, there is a general correspondence of bison and microblade technology. However, the Gerstle River and Broken Mammoth data suggest that in Interior Alaska, wapiti was as important or more important than bison as a food resource in the Early Holocene. Another argument against the prey-specific model of microblade use is that such a one to one correlation would act to limit flexibility in hunting decisions. The resulting expectation of limiting hunting forays to a single species, especially given the overlapping habitat and diet of many species (bison and wapiti for instance), appears to be unreasonable. The association of microblade technology with faunal remains *in general* appears to be supported by the radiocarbon dated components (see below).

Different Functions

Given the clear pattern that composite points and bifacial points co-occur within the same technological complexes, they may reflect different functions. Given the morphological and technological analysis of microblades and composite points above, there are limited tasks for which composite points could function as an armature. The model here considers thrusting spears, javelins (hand-thrown spears), darts (atl-atl thrown spears), and knives. Arrow points are rejected based on the data above. Guthrie (1983b:350) cites (1) the Kokorevo II site where a composite point was embedded in a bison scapula (Abramova 1979) and (2) limited functionality of "fragile" composite pieces as knives due to torosional stress as the major evidence for composite point function. Guthrie (1983b:352) notes that the edge of the implements would result in more severe damage upon penetration of an animal than a simple organic point. However, this does not necessarily mean that a projectile point is the only possible function for composite tools. These patterns could indicate functionality as a thrusting spear point as well. Guthrie (1983b:360) observed through his experimental work that antler points are flexible and strong, "almost indestructable," though warping still occurred, and the microblade insets were more fragile.

Taking all of these data into consideration, a model of microblade use as side insets into composite tools is presented here for the Gerstle River site. This model does not encompass end modified microblades, which probably functioned within a different class of tools (see above). Microblades may have functioned as blades within removable composite/slotted spear points. While composite points may have been effective as projectile points on darts thrown with the aid of atl atls, several factors suggest their use as multipurpose tools. These factors include presence of dual point systems (composite and bifacial). Late Pleistocene and Early Holocene bifacial projectile points in Interior Alaska have a general pattern, small to medium sized triangular to lanceolate points. Lanceolate, notched, and tanged forms have been found affixed to dated atl atl darts in the Yukon Territory from over 8000 BP to around 1250 BP (Hare et al. 2004). Composite tools in Alaska and Siberia have been found in a multitude of forms suggesting both knives (large, flat, and thin) and points (long with an oval cross section). This model does not propose that all composite points functioned as spear points, but rather that a spear point forms were more common than dart points.

The composite points would be set at the tip of a hand-held spear. These spears could function as personal protective equipment for dispatching wounded game or for defense. The composite point bases were beveled or tanged and could be removed for use as knives if a situation warranted. The composite point would be a heavily curated tool (as personal gear) and would be more rarely manufactured than would be expected of dart points. Use as dart points would have necessitated increased numbers, as risk of breakage is higher and the prehistoric hunters would want to replace them as they were broken. Once released, the chances of breakage would increase (faster speed, possibility of missing and hitting the ground, striking bone, etc.). Function within a thrusting spear system would result in much less of a chance for breakage, and replacing microblades as they would dull or break would be the primary maintenance task. The difficulty in carving channels in organic tools without substantial modification (soaking in water, etc., Guthrie 1983b:353) suggests that microblades would be manufactured in such a way as to maximize the options in order for retrieval of microblades shaped for a specific organic point. This would explain the relative lack of differences in width for used and unused microblades and may explain the high ratio between used and unused microblades. Many of the microblades thought of as well suited for microblade insets were not actually used. A reasonable explanation was that the artificer was not manufacturing microblades strictly within a set mental template for shape, length, width, and thickness, but rather was producing a large number of microblades to offer choices in selection for inset into a *particular* organic point.

A detachable composite point would be well suited for a number of tasks, penetration and slicing soft material as two of the primary tasks. Hunting large mammals like bison and wapiti in prehistoric times was undoubtedly a hazardous task, made more dangerous when dealing with wounded animals. The possession of a weapon that could dispatch wounded animals would be a necessity. This model explains the functions of dual weapon systems present in microblade using populations. Bifacial projectile points, present in most Denali Tradition sites would fulfil the role that they do in other complexes; namely, affixed to the end of a dart launched by means of an atl atl from a distance to penetrate the prey objective. Composite points fulfilled the dual functions of spear tip for dispatching wounded prey and knife for other general tasks.

The morphology of composite points supports this model. Multiple quick punctures of wounded animals would require the point to be smooth (unlike bifacial points) for repeated entry into the carcass. There is no evidence of barbed points or positioning of microblades in oblique angles relative to the long axis of the point in Siberian and Alaskan examples. This suggests that a smooth contour was the objective in fashioning microblades to inset into lateral edges of the point. The ubiquity of microblades can be explained by their dual function as part of a multi-purpose spear tip and detachable knife that could be used for many tasks requiring slicing or cutting. In the course of use, the microblades would likely be damaged more than the organic point (Guthrie 1983b:360), and thus would require refurbishment on a regular basis.

The loss of microblades (around 1000 BP) is contemporaneous with a number of technological, subsistence, and settlement changes that I think are inter-related. Bison, a gregarious animal present throughout the Holocene, probably decreased in population due to increasing muskeg and paludification in lowland and bottomland areas near rivers. Bison probably became extinct around 1000 BP (Stephenson et al. 2001). It is possible that more efficient hunting technology with the introduction of the bow and arrow, dating to 1250 BP in the adjacent Yukon Territory (Hare et al. 2004), may have accelerated the extirpation of bison in Interior Alaska. With bison effectively gone, and with moose unlikely to fulfil the part of herd animals capable of sustaining local populations through the winter, caribou became the primary food source. This likely put severe stress on human populations. The radiocarbon date gap between 1000 and 700 BP (Potter 1997) may reflect population decreases during this period. After 700 BP, a new strategy had developed, with intensive salmon exploitation in certain areas in the summer, with seasonal hunting of caribou in spring but primarily fall (Potter 1997). This pattern is reflected in the settlement system, with the first evidence of cache pits and house pits near rivers, fish camps near winter villages, and specialized hunting camps for caribou and sheep.

This pattern is reflected in the technology as well, with decreasing use of lithic materials, especially high quality flaked stone, and an increase in organic technology. This is likely due to the reduced mobility necessary for storage of salmon over-winter and the increased use of local raw materials near fish camps and rivers or prey-derived resources (wood, bone, antler). Microblades were generally flaked from high quality stone raw materials, and this part of the toolkit, as well as burins, bifaces, and many other flaked stone implements, were not common within this new technological system (see Workman 1976). The last flaked stone in the record included end scrapers, wedges (pieces esquilles), and utilized flakes. Finally, these were replaced as copper and imported metals became more available through trade. Other materials besides wood and bone may have replaced composite points in other parts of Alaska. Steffian et al. (2002) note that "the demise of microblade technology coincides with the widespread use of bayonets, long-edged, ground, slate lances (Clark 1982)" in the Kodiak archipelago, and they suggest a functional relationship between these artifact forms.

The model presented above affords the most versatility and flexibility for composite tools while reflecting the extant organic composite tool variability. A more conservative version of this model would be the function of composite points as projectile points in addition to spear points and knives. This model should be seen as tentative, and the extant data cannot be used to confirm or reject it. The presence of composite dart points in the Yukon Territory support the notion that at least some of the composite points were used as dart projectile points. Again, this model does not propose that composite points were exclusively used as spear points, but that proportionally more may have been used as spear points. As noted above, there is limited circumstantial evidence for some prey-specific relationships with microblade technology, and this too may play a role in how this technology was utilized with bifacial projectile points and other tools.

Technological Organization

This section analyzes the data presented in the debitage and microblade industry analyses of this chapter, along with microblade and modified flake technological analyses in Chapter 7, and incorporates specific tool information in order to characterize technological organization among Gerstle River assemblages. The dimensions of technological organization examined here include raw material use, assemblage composition, and lithic reduction. Results from these sections are used to address site function, curation, and mobility.

The patterns relating to spatial organization at the site (hearth features, lithic concentrations, faunal clusters) suggests that highly resolved flaking events may be delineated. Detailed spatial analyses of the patterns described below are presented in Chapter 10.

Raw Material Use

Availability of lithic raw materials, especially high quality cherts and chalcedonies, are well represented at Gerstle River; however, only the latest stages of reduction are represented, microblade production, core rejuvenation, and unifacial and bifacial tool maintenance. There are a number of raw materials represented at both Gerstle River and nearby Healy Lake Village sites, suggesting that some sources were located nearby (see Chapter 7). The few specimens with cortex at Gerstle River indicate that the form of chert raw materials were likely river-worn cobbles (~10 cm diameter), probably acquired from nearby glacial outwash areas, largely denuded of vegetation.

The use of raw material is examined at Gerstle River in a number of ways, including relative percentages of tools and debitage, expedient vs. formal tool frequencies, and tool formality indices (derived by dividing expedient tools by formal tools and multiplying by 100) for each material type. Richness (number of material types) and evenness (relative distribution of artifacts by material types) is calculated for each component. Data are presented in Table 8.14 and Figures 8.17 and 8.18. Table 8.15 lists all chipped stone raw material types for each component, including numbers of debitage, tools, debitage/tool ratios, presence of microblades, number of expedient and formal tools, and tool formality (expedient tools/formal tools x 100). Figure 8.17 illustrates the relative frequencies of material types for all components. Figure 8.18 compares number of artifacts and number of raw material types for each component.

In terms of richness, Component 3 has many more material types than the other Components (20 vs. 2-7). However, sample size is directly related to richness measures, in this case $r=0.95$, $r^2=0.91$. In order to examine assemblage evenness (in this case, number of artifacts of each material type), I used the Simpson Diversity Index (SDI, calculated as 1-D) (see Rindos

1989). Shannon-Weaver Diversity Index (H') is presented for comparative purposes, but generally reflects SDI. SDI ranges from 0 (distributions are least even) to 1 (most even), and the value is only moderately affected by sample size (SDI, r^2=0.47). Components 2 and 3 are relatively evenly distributed in material types (SDI=0.86 and 0.95 respectively), Components 1 and 5 are somewhat less so (SDI=0.75 and 0.76 respectively), and Component 4 is least even (SDI=0.51). A plot of number of lithics (chipped stone) by number of material types (Figure 8.18) shows that Component 1 is represented by fewer material types given its sample size relative to the other components. Given the similarities in Components 2 and 3, Component 1 appears to be the most divergent in terms of material use. No microblades were found in this component, and while the lack of microblades in Components 4 and 5 may be due to sampling errors, their lack in Component 1 is probably not. Given the differences in technology in Component 1 (see below), these data further support the differentiation of Component 1 from the other components.

The Gerstle River data can be used to examine use of raw materials over time. While some continuity in material types is evident, especially between Components 2 and 3, each component is dominated by different material types. Component 1 is dominated by C5 (87%), Component 2 is dominated by Ch1 (76% in Area E) and Qa1 (97% in Area F), Component 3 is somewhat less dominated by C1 (49%), Component 4 is dominated by black chert (98%), and C5 is relatively evenly divided among R2, Ar, and O. Only Qa2 is present between Components 1 and 2, whereas C1, Ch2, J1, and R2 are present in both Components 2 and 3. Material C4 and C6 is present in both Components 3 and 4. Only Ch2 and R2 is present in three components, suggesting they may have had relatively local sources. No material type is present in four or all five components. However, given the small sample sizes of Components 4 and 5, these patterns are tentative. Materials considered local based on Component 3 frequencies, weights, and percent of modified specimens (see Chapter 7) also had relatively high frequencies in other components.

Two dimensions of raw material availability were examined at Gerstle River, quality and abundance. Following Andrefsky (1994), the relatively low debitage to tool ratios (Table 8.15) suggests that lithic abundance was relatively low. The variable tool formality indices indicates that material abundance estimated as "local" was probably high and "exotic" was low (Andrefsky 1994:30). The variability in tool formality (as well as the number of material types and differences in quality) suggests that raw materials were obtained from both local and distant sources.

Materials used for microblade production did not show any patterns with respect to debitage/tool ratios and tool formality indices (Table 8.15). Tool ratios for materials used for microblade production where n>30 (n=8) had debitage/tool ratios of between 5-21(avg. 21±13) vs. 3-353 (avg. 112±150) for other materials (n=9). Tool formality indices were also not different, with microblade materials ranging from 0-69 (avg. 21±25) and non-microblade materials ranging from 0-900 (avg. 217±331). Standard deviations for these measures are high for both groups, but coefficients of variation for microblade materials are lower than those for non-microblade materials (64 vs. 133 for debitage/tool ratio and 133 vs. 153 for tool formality index), indicating more variability in tool production in the non-microblade material groups. While microblades are considered by Owen (1988:57) to be manufactured from different raw materials than bifaces in the Arctic, and chert was the only material type in her Subarctic Alaska sample, the microblades at Gerstle River were manufactured from a wide variety of materials (including chert, obsidian, chalcedony, rhyolite, argillite, and jasper). Most microblades were manufactured from high quality materials (99% in Component 2 and 62% in Component 3). The only lower quality material used in microblade production was andesite (n=8 microblades, <1%) in Component 3. This wide variety of material types is similar to that seen at Dry Creek and Healy Lake Village, and these results suggest that material quality (high vs. medium) did not appear to be a constraint on microblade technology in Interior Alaska.

Specific tool classes were apparently not organized by particular material types. For instance, microblade cores, core tablets, microblades, and burin spalls were from a wide range of materials. However, burins (n=4) were more likely to be made from exotic brown chert (C6), including 2 of the 3 specimens in Component 3 and the only specimen in Component 4. While all three are made from brown chert, differences in color and inclusions suggest they are from different sources. One of the beveled flakes (n=7) was also made of C6. Bifaces and the remaining unifaces were made from local material, generally gray and black chert (C1 and C4). Modified flakes were made on both local and exotic materials (see Figure 8.3). Modified flakes in Components 1 and 2 appear to be curated more than those of Components 3 and 4 (i.e., they were made from materials for which there was little or no debitage at the component). This patterning suggests that burins were more heavily curated prior to discard onsite, whereas the bifaces and unifaces, as well as the retouched flakes (in Components 3 and 4) were less curated and the size differences between Component 3 and 4 modified flakes and unmodified flakes suggest that some of these implements were likely manufactured off-site (see Figure 7.43-7.46, and 7.51).

Planned vs. opportunistic collection of raw materials cannot be evaluated based on the Gerstle River data, as initial reduction would occur in both instances at the quarry location, and less would occur at camps such as Gerstle River. However, the presence of multiple high quality material types of different lithologies, including obsidian from over 200 km away, indicates that some logistical planning for raw material procurement was employed or trading networks were established by the Early Holocene.

There is a profound emphasis on high quality materials in most components. High quality materials (obsidian, chalcedonies, and most cherts) formed 87% of Component 1 lithics, 57% of Component 2, 63% of Component 3, 1% of Component 4, and 23% of Component 5. Medium quality materials (rhyolites, argillite, jasper, Qa1, and some cherts) made up most of the remainder, 43% of Component 2 lithics, 35% of Component 3, 98% of Component 4, and 77% of Component 5. Low quality materials (andesite, basalt, dacite, quartz, most quartzites, and siltstone) were present in very low frequencies, 13% of Component 1, <1% of Component 2, and 2% of Component 3.

Table 8.14 Richness and diversity of material types per component.

Component	*Number of lithics*	*Material types (k)*	*Evenness (Simpson's 1-D)*	*Shannon-Weaver Diversity Index (H')*
Component 1	2040	4	0.75	0.48
Component 2	828	7	0.86	1.20
Component 3	7077	20	0.95	1.79
Component 4	43	2	0.51	0.11
Component 5	86	5	0.76	1.14

Assemblage Composition, Curation, and Mobility

The tool classes present at Gerstle River fall entirely under general Denali Tradition parameters (West 1967, 1981; Powers et al. 1983). Specific tool and core types are consistent as well, with the possible exception of the semi-conical microblade cores. As noted in Chapter 7, morphologically similar cores are found at sites considered to be associated with the Denali Tradition, such as Healy Lake Village (Cook 1969), Panguingue Creek C2 (Pontti 1997; Goebel and Bigelow 1996), and Whitmore Ridge Component 1 (West et al. 1996c). However, it should be noted that with the widespread spatial and temporal distribution of microblade technology

Table 8.15 Debitage, tool, formal and expedient tool data by material type and component.

Component	Debitage[3]	Tool[4]	Total	Debitage/ Tool	Microblade	Expedient tools	Formal tools	Tool Formality
Component 1	2034	6	2040	339		3	3	100
An	107	0	107	-				-
C5	1764	5	1769	353		2	3	67
Q	163	0	163	-				-
Qa2	0	1	1	0		1		-
Component 2	803	25	828	32		3	22	14
C1	49	11	60	5	Yes	2	9	22
Ch1	360	9	369	40	Yes		9	0
Ch2	39	3	42	13			3	0
J1	0	2	2	0		1	1	100
Qa1	329	0	329	-				-
Qa2	1	0	1	-				-
R2	25	0	25	-				-
Component 3	6827	246	7077	28		67	177	38
An	119	0	119	-	Yes			-
Ar	412	24	436	17	Yes	2	22	9
B	4	0	4	-				-
C1	3320	128	3449	26	Yes	40	87	46
C2	554	0	554	-				-
C3	15	9	24	2	Yes		9	0
C4	836	27	864	31	Yes	11	16	69
C6	0	5	5	0		2	3	67
C7	183	16	199	11	Yes	3	13	23
C8	3	0	4	-	Yes			-
C9	96	0	96	-	Yes			-
Ch2	17	0	17	-	Yes			-
Ch3	138	0	138	-				-
D	8	0	8	-				-
J1	4	1	5	4	Yes		1	0
J2	0	1	1	0		1		-
O	64	13	77	5	Yes		13	0
R1	417	13	430	32	Yes		12	0
R2	634	5	640	127		4	1	400
S	3	4	7	1		4		-
Component 4	33	10	43	3		9	1	900
C4	33	9	42	4		9		-
C6	0	1	1	0.0			1	0

[3] Debitage in this table includes unmodified microblades, flakes, flake fragments, and shatter.
[4] Tools in this table include modified microblades and other modified implements.

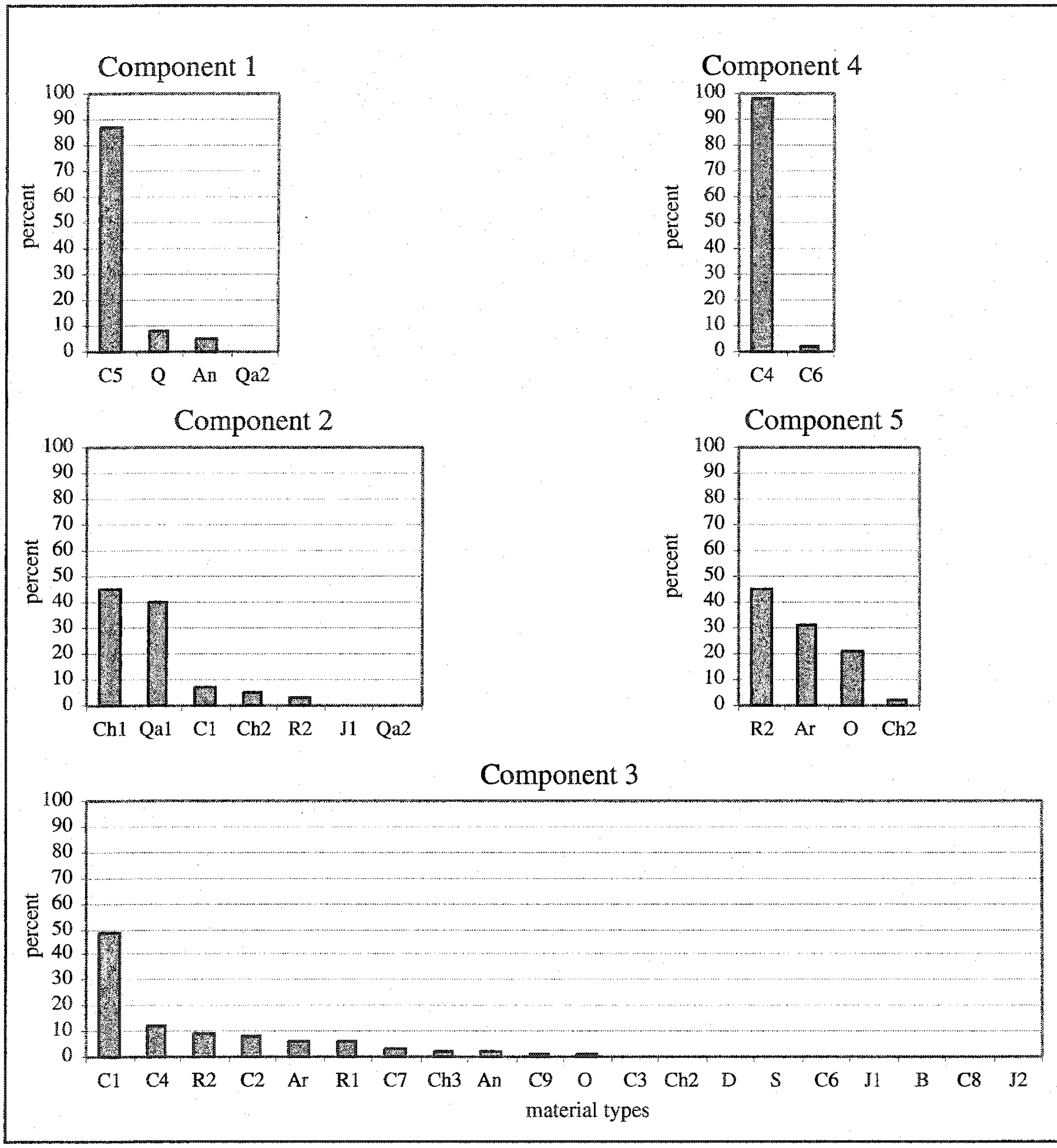


Figure 8.17 Raw material distributions by component.

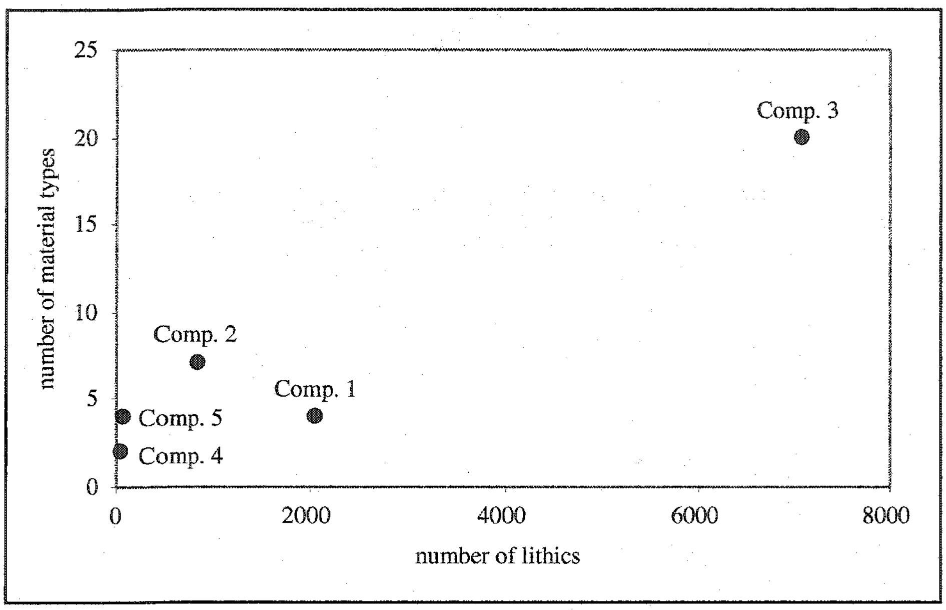


Figure 8.18 Number of lithics and number of material types by component.

(including wedge shaped microblade cores), the Alaskan record may parallel the Siberian record with variations in other parts of the toolkits being used to define archaeological units (Vasil'ev 2001:5-6, 19). Given (1) the ubiquity of microblade technology, (2) the recurring association of specific tools (including burins) that makes it easy to separate sub-assemblages on the basis of microblade technology alone (see Goebel 1990; Goebel et al. 1991), and (3) the lack of understanding of intrasite assemblage variation within Late Pleistocene and Early Holocene sites in the region, I suggest a reconsideration of typology and taxonomy of all assemblages regardless of microblade content is necessary. A closer examination of site structure and organization is also warranted, including how tool classes and tool types covary with respect to each other and to site structural information (features, fauna, etc.).

Of the largest group of Denali artifact spatial clusters (found at Dry Creek Component 2), the Gerstle River Component 3 assemblages are most similar with Clusters C and G, with the co-occurrence of microblades and associated cores and core debitage, bifaces, and burins. Unifaces are absent in Dry Creek Component 2 microblade clusters, but other microblade sites have short-axis beveled flakes (see Chapter 3). The two types of microblade clusters are interpreted by Hoffecker (1983a) to be spear production and maintenance (clusters A, B, N) and spear production, maintenance, bone antler working, meat processing, and skin working (C, G).

That a number of tool classes appearing at Dry Creek Component 2 were absent or found in low numbers at Gerstle River Components 2 and 3 suggests (a) the range of activities performed at the latter were similar to the former but less varied or (b) site activities were different. These tool classes include bifacial projectile points, other bifaces (knives?), (flake) core scrapers, denticulates, perforatorss, and notches. All but projectile points, bifaces, and core scrapers were found in low quantities at Dry Creek Component 2 (n<4 in each category), suggesting a sampling phenomenon. Given our present knowledge, it is unclear how to interpret the relative paucity of bifaces and projectile points at Gerstle River Components 2 and 3.

In characterizing assemblage composition, two dichotomies have been expressed in various ways in the archaeological literature, mobile vs. transported toolkits and curated vs. expedient assemblages or tools (Binford 1979; Bamforth 1986, 1991; Shott 1986; Kuhn 1994; Odell 1996; Nash 1996). In many ways, these dimensions incorporate very similar assumptions and inferences. Mobile toolkits are thought to be composed of generally curated tools, which are identified on the basis of relatively high formality (i.e., low expediency), relatively small size, portability, flexibility, and versatility in tool forms, increased use of storage or caching. Bamforth (1986) discussed five aspects related to curation, tool production prior to use, tool versatility, transport, maintenance, and recycling or refurbishment. However, as Bamforth notes, "there is no reason to assume that all of these kinds of behavior always occur together" (1986:39). This present study examines these individual dimensions of technological organization in the context of the Gerstle River data.

A series of expectations are derived from the literature and compared with data from Gerstle River in order to summarize and evaluate these technological organizational dimensions among the components. Specific expectations are (1) production of tools in anticipation of future use, (2) extensive resharpening, reuse, or recycling of implements, (3) conservation/ maximization of high quality lithic raw materials, (4) high relative frequencies of formal tools, and (5) low debitage/tool ratios. Other data, such as patterns of lithic raw material use are described above.

The high formality of microblade technology indicates planning for future technological needs. However, because this technology appears to play only a part within a larger technological system (see below), an inference of increased curation cannot be sustained, beyond the general inverse relationship between core size and portability. In addition, the mixture of formal and expedient tools at Gerstle River components suggests that a more complex relationship exists between tool formality and position of sites within a settlement system.

Because bifacial tools are uncommon in Gerstle River assemblages, normal means of assessing resharpening or recycling implements cannot be used. Another way to measure the extent of tool recycling is to compare the percentage of utilized margins on modified flakes (see Chapter 7) (Table 8.16). Modified flakes in these components were not significantly different with respect to percentage of modified margins ($F=1.82$, $df=75$, $p=0.151$). However, Fisher's PLSD test showed Component 3 flakes had significantly lower percentages (mean difference of 14%) of modified margins than Component 4 modified flakes (14% mean difference, PLSD value = 14.01). The components were relatively similar in having about half of the total edges modified in some fashion (Table 8.16). Both specimens in Component 2 Area F were modified on 75% of their margins, and both were small fragments, suggesting they were broken from a larger tool. No refits were located for these tools, and they represent rare materials among Area F debitage (J1 and C1). Thus, with the possible exception of Area F in Component 2, there does not appear to be evidence of extensive reuse or curation of modified flakes in the Gerstle River assemblages. Recycling is considered minimal at Gerstle River Components 2 and 3, given the relative lack of bifaces, unifaces, and relatively light use wear exhibited by the modified flakes.

Table 8.16 Modified flake average percentages of modified margins by component.

Component	*N*	*Average percentage of modified margins*	*cv*
Component 1	3	47±21	45
Component 2	3	58±29	50
Component 3	61	43±19	44
Component 4	9	57±19	33

Microblade technology is geared toward producing small blades as insets for tools. Given the small size of microblade cores (high portability), this technology could be seen as maximizing or conserving raw material for groups with high residential mobility (see Goebel 2002, Sheets and Muto 1972, Rasic and Andrefsky 2001). However, bifacial cores are portable units for producing usable flakes as well (MacDonald 1968; Parry and Kelly 1987; Kelly and Todd 1988; Rasic and Andrefsky 2001). Given these similarities, a dichotomy of microblade core / bifacial core is not likely to be useful in assessing mobility in the absence of information about blank selection.

Mobility can be characterized by higher degrees of formality in tool design and curation and maximization of lithic raw materials, especially those of high quality (Kuhn 1994; Odell 1996). Tool formality relates to the regularization of tool types, reflected in degrees of symmetry, standardization, and/or degree of modification. Formal tools at Gerstle River include modified microblades, burins, burin spalls, unifaces, and bifaces. Expedient tools include modified flakes and cobble tools, such as spall scrapers and hammerstones. The Gerstle River Component 3 (and to a lesser extent Component 2) assemblage is composed of a mixture of both sets of tools. Modified microblades produced through formalized technological process from specially prepared cores (see Chapter 7 and above) are the most common tools in these components in terms of number (147 vs. 138). However, expedient tools like modified flakes and spall scrapers constitute a sizable portion of the tool assemblages (29%). The data suggest that the tools manufactured on-site were likely limited to modified flakes and spall scrapers, and at least some of the modified microblades. Both curated "toolkits" and expediently produced tools were used for the tasks conducted at the site or in preparation for future tasks. Without a larger sample of dated components and spatial analyses, developing inferences based on toolkit composition and assemblage composition is likely to be constrained by unknowns about technological organization.

Debitage/tool ratios are described above (Table 8.15). The relatively low debitage to tool ratios may indicate curation and/or maximization of higher quality raw materials, but our lack of knowledge about material source locations for all of the types except obsidian renders inferences based on thee ratios tentative. As noted above, there are differences in the ratios between materials used for microblade production and those not, suggesting microblades were preferentially made on high to medium quality raw materials. The issue of mobility and conservation of materials is another organizational dimension, and one that cannot be addressed without more understanding of the role of microblades within technological systems in this region.

Patterns of lithic raw material use (presented above), including the low occurrence of cortical flakes and the presence of formal tools of exotic materials (especially O and C6) suggest maximization of lithic resources was practiced. Certainly, high mobility and high curation are related, and the large number of material types, many of which may be exotic (in the strict sense of a long distance to the material source(s)) suggests high mobility (see Odell 1994). The technological organization of general early Alaskan microblade assemblages, largely derived from Late Upper Paleolithic industries in Siberia, is noted for both portability and efficiency (potential for usable blanks relative to core size) (Flenniken 1987; Bamforth and Bleed 1997; Elston and Brantingham 2002).

Core and blade technology in general and microblade technology in particular has been considered very efficient in terms of usable edge per gram of raw material (Sheets and Muto 1972; Guthrie 1983b; Flenniken 1987). However, an experimental study comparing blade cores and bifacial cores has shown that in a number of ways (number of usable items relative to core mass and flexibility of the bifacial core), the two technologies yielded similar measures of efficiency (Rasic and Andrefsky 2001). Given the ubiquity of microblade technology in time and space in Interior Alaska, and the diversity of assemblages within which they are found, I suspect that microblades form a portion of Paleolithic toolkits that is constrained by morphological parameters rather than technological parameters. By this, I mean that this technology probably was not a localized response to raw material acquisition or transport costs, but was constrained rather by the limitations imposed by the products (i.e., microblades). These limits are morphological in nature (small, brittle, and capable of only limited arrays of motion, see above) and imply a relatively limited set of functions. A prediction of this model would be that the patterns of occurrence of microblade technology would reflect utility for different tasks rather than generalized use for specific seasons or use in relation to distance from lithic raw material sources.

While some archaeologists argue that we do not have enough information to infer degrees of residential or logistical mobility in the Beringian Late Pleistocene/Early Holocene (Goebel 2002:126), the lack of caches or storage areas in Alaskan during this period suggests that residential mobility strategies were used to cope with subsistence contingencies. Gerstle River data is considered to be consistent with high residential mobility expectations. Area-specific analytical results are presented in Chapter 10.

Lithic Reduction Stages

Only a small portion of the entire lithic reduction sequences practiced by Gerstle River flintknappers are represented on site. Based on the debitage analysis, only late stage reduction and maintenance is present at Gerstle River Components 1, 2 and 3. Components 4 and 5 likely reflect similar stages of reduction, but the sample sizes are small. Lithic reduction tasks within

Components 2 and 3 include (1) microblade production, (2) microblade core rejuvenation through platform and face removals, and (3) maintenance of unifacial and bifacial tools. Bifacial thinning flakes were rare in the debitage sample and generally limited to materials with no associated microblades (see above). A number of bifaces were likely resharpened or maintained in Components 2 and 3, but only one biface and one biface fragment were recovered from the latter, suggesting that overall tool maintenance was a minimal part of component activities.

The lack of larger sized (>10 mm) flakes makes it difficult to reconstruct primary lithic reduction techniques, including percussor types. Very few hammerstones were found (none for Components 1, 2, 4, and 5 and only two in Component 3). No anvil stones, used as a platform for bipolar reduction, were found, and no bipolar flakes were observed in the flake sample. For these reasons, hard hammer percussion is unlikely for the reasons stated above, but soft hammer (using antler billets), indirect percussion, and pressure techniques were likely used in each component. Replicative work on wedge shaped microblade cores indicates that while both percussion and pressure were used to form the mlcroblade core, pressure flaking was used principally in microblade production (Flenniken 1987), and these results support this contention.

Site Function Based on Lithic Assemblages

Various Paleolithic site typologies have been constructed on the basis of ethnographic analogy and site structural studies (Binford 1978b, 1980, 1983a; Chatters 1987; Chang 1968; Jochim 1976), including long-term and short-term residence sites, short term encampments, specialized stations (lithic quarry sites, butchery sites), and kill sites. The purpose of this section is to evaluate site function on the basis of lithic assemblage characteristics at Gerstle River components. A more detailed examination is provided in Chapter 10. There is insufficient information on assemblage structural, site organizational, and site structural characteristics in Interior Alaska to develop a site typology for early prehistory in this region. Rather than constructing such a typology in a post hoc accomodative way, I decided to evaluate the Gerstle River assemblage data in the context of a commonly used continuum defining hunter-gatherer mobility (Binford 1980).

Binford distinguished two basic classes of site types of hunter-gatherers, residential sites and special-purpose sites based on his Nunamiut studies within a continuum of mobility from foraging (residential mobility) to collecting (logistical mobility) (Binford 1978b, 1980). Overly dichotomous categorizations often result in oversimplifications of the relevant patterning. I believe a more appropriate way of understanding these two concepts is that they are not mutually exclusive means of adapting to local contingencies of resource acquisition, but rather two dimensions of hunter-gatherer variability that are both reflected in habitation and mobility strategies. The basic distinction between these settlement strategies is mobility in reference to resource areas and type of resource scheduling (see Binford 1980:339-347). At the foraging end of the continuum, people gather resources on an encounter basis within specific resource areas, there is a lesser dependence on storage, and group size varies relative to the type and abundance of the resources. At the collecting end of the continuum, resource procurement is logistically organized relative to specific resource locations in the landscape and food storage is critical (Binford 1980:344). Archaeological characteristics vary relative to two types of forager sites, residential bases and locations. Assemblage size is variable in residential bases, and is generally conditioned on the abundance and availability of resources. Assemblage size and variability is low in locations, which are used for acquiring specific resources (Binford 1980:343). Logistically mobile populations employ a more varied suite of site types, including the foraging types (residential base and extractive locations), but with the addition of field camps, stations, and caches (or storage sites) (Binford 1980:346-347).

A number of researchers have used Binford's original model in the context of lithic assemblage characteristics (e.g., Kelly 1983; Shott 1986; Chatters 1987; Kelly and Todd 1988). Tool diversity is expected to be high at residential camps, somewhat less in field camps, and low at stations and locations, reflecting more specialized and narrower ranges of activities (Chatters 1987). The evenness measures for Gerstle River components based on tool classes (Table 8.17) are relatively high for Components 1, 2, and 3, but low for Component 4. Again, richness (k) is highly correlated with sample size ($r=0.98$, $r^2=0.95$). A relatively restricted range of tool classes dominate the Component 2 and 3 assemblages, primarily microblades, burins, and burin spalls. When these components are compared to Dry Creek microblade clusters, Clusters A, B, and N (Group 1) contain 4-5 tool classes, whereas Clusters C and G (Group 2) contain 6-7 tool classes. Among the Dry Creek Component 2 clusters, the largest amount of faunal remains were associated with Cluster G, and there was fauna associated with Clusters C and N (Clusters A and B contained no faunal remains, and had fewer tool classes).

Table 8.17 Richness and diversity of tool classes per component.

Component	*Number of tools*	*Tool classes (k)*	*Evenness (Simpson's 1-D)*	*Shannon-Weaver Diversity Index (H')*
Component 1	6	3	0.80	1.01
Component 2	25	4	0.78	1.09
Component 3	248	9	0.89	1.23
Component 4	10	2	0.56	0.33
Component 5	0	0	N/A	N/A

To evaluate if components with microblade technology were more likely to have associated faunal remains than non-microblade components, I conducted another χ^2 test on those components listed in Table 8.12. While the tests show no significant correlation (χ^2=0.833, df=1, p=0.362; Yate's χ^2=0.323, df=1, p=0.570; Fisher's Exact p=0.182), several factors suggest that fauna may be more associated with microblade components (see Figure 8.19). These tests did not take into account taphonomy, which may have affected the distributions. For instance, Phipps, Sparks Point, and Whitmore Ridge C1 are located in the Tangle Lakes area, where site stratigraphy is shallow and very few faunal remains have been preserved. Excluding these components reduces the p value to 0.068 for Pearson's χ^2 (χ^2=3.34; Yate's χ^2=2.1; df=1, p=0.150; Fisher's Exact p=0.061). These results suggest that microblades, *as a class of artifacts*, may be strongly associated with faunal remains. A number of factors may account for this. Microblade technology may be more associated with hunting-related activities than other tool classes like bifacial projectile points, which could occur in more varied contexts. Microblade technology may be more strongly associated with butchering activities, though the morphological analyses presented above would suggest that microblades set into composite points or knives would have limited utility for a wide range of butchery activities such as hide stripping and dismemberment. The sample size is too small to infer specific processes, but the point here is that this pattern reinforces the hypothesis that microblade technology formed a subsystem within technological systems whose organization was conditioned by subsistence and settlement (logistical and residential mobility) rather than complete technological systems that represent prehistoric cultures. It is in this context that microblade technology offers an avenue for inquiry into human behavior with respect to settlement and mobility patterns and subsistence behaviors, as reflected by technological organization.

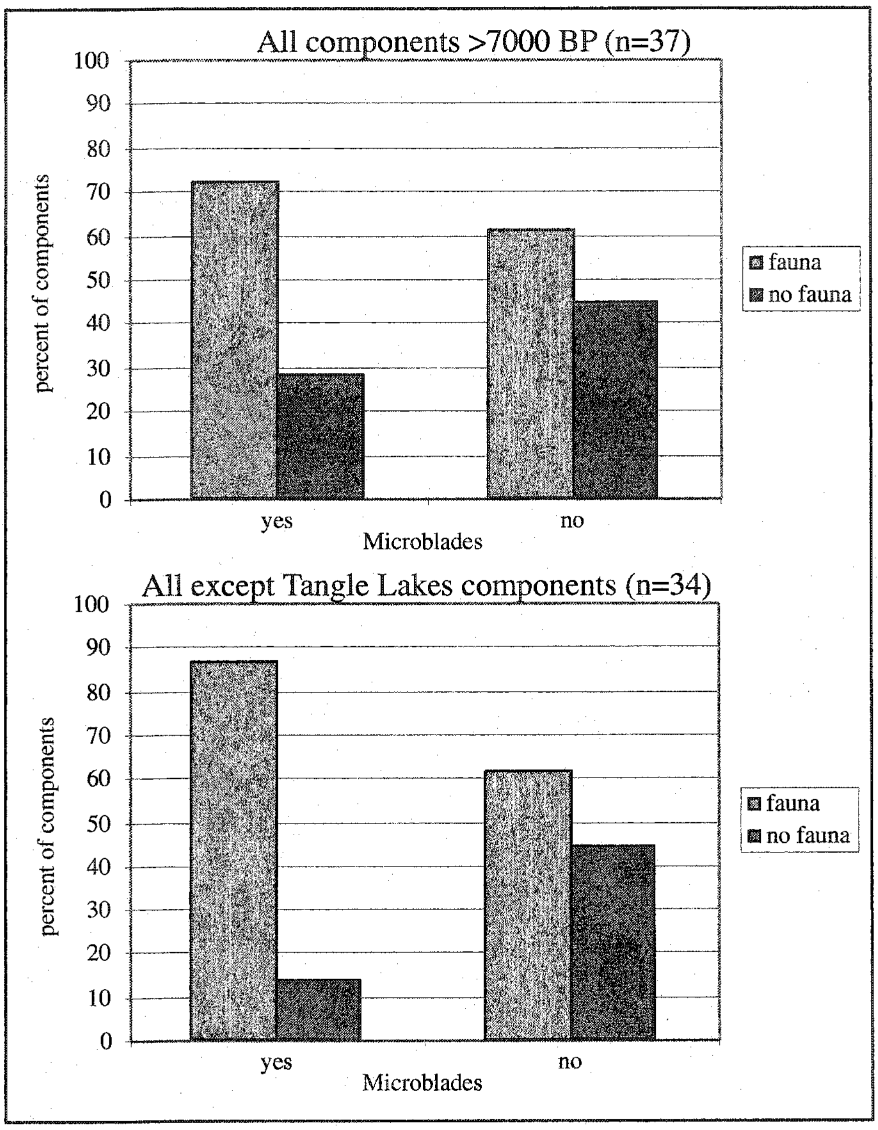


Figure 8.19 Microblade and fauna presence in Interior Alaskan components older than 7000 BP. Top, all components, bottom, all components except Tangle Lakes components.

The possible strong association with faunal remains may indicate a restricted range of activities in Gerstle River Components if microblades reflect narrow ranges of tasks. As described above, microblades were likely used for multiple functions, thus, this cannot be used as evidence of a limited range of behaviors at the site. In addition, the presence of faunal remains representing a relatively limited array of butchery and processing related activities and numerous potentially contemporaneous hearth features suggests that Gerstle River Component 3 may represent a short term camp where a larger array of tasks were performed (see Chapters 6 and 9).

Expectations of specific stations and locations (following Binford 1980) include a very narrow range of tool types (low diversity) depending on the number of tasks performed at the site. Evaluations of Gerstle River components as stations (quarry sites, kill sites, storage or cache, observation sites) and/or field camps are made below.

No quarry has been located nearby, and no quarrying related activities (such as early core reduction) took place within any of the Gerstle River Components. Very tiny (<1 mm) tertiary flakes dominate the record in all components. A variety of material types are present in Component 3, without one being totally predominant (see above). No manufacturing rejects are present that would indicate that the site was located near a lithic quarry. The absence of early and middle stage reduction debitage in Components 2 and 3 indicates that tool manufacture was not a prominent activity at Gerstle River during these occupations. While "local" is used in this section to denote relative frequencies of lithics at the site, none can be considered local in the sense of a nearby lithic quarry. Debitage analysis suggests that tool maintenance and microblade production were the primary lithic reduction process in Components 2 and 3.

As demonstrated in Chapter 6, there is no indication based on the fauna that Gerstle River Component 3 represents a kill site. Based on the data presented in Chapter 6, the kill sites were probably located relatively nearby. The lithic assemblage data for Components 1 through 5 are not dominated by projectile points (broken or otherwise), and the presence of multiple features (Chapter 9) and the Lower Locus' sheltered topography (Chapter 3) suggests the components may more likely be temporary field camps. There is no evidence of storage or caching behaviors at any of the Gerstle River components. No pit features, faunal middens, or lithic tool caches were present.

The Gerstle River site could certainly function as an observation point, with a wide view from the east to south to west, overlooking a variety of ecological zones, including lowland forests in the immediate surroundings, a braided stream one mile distant, up to the edge of glaciated terrain 4 km to the south. However, observation could be one of many functions of most of the excavated early prehistoric sites in Interior Alaska. The presence of the southern hill south of the Lower Locus, that would block most of the view to the south would suggest that the tasks performed at the excavated Lower Locus proper likely did not include general observation, though the southern hill itself likely served this purpose. It would have been very instructive to have excavated on the hill top itself before it was destroyed in 1995 to compare assemblage and site organization between the two areas.

Lithic data from Component 1 suggests it may have functioned as a very short term camp or flaking station where late stage reduction of bifacial implements occurred, perhaps manufacturing or resharpening projectile points to replace broken specimens. Each cluster within Components 2 and 4 likely represent single very short-term occupations with a very narrow range of tasks. The variability in the Component 5 sample is too limited to be used to infer site function.

The data for Component 3 are used to generate a lithic reduction, use, and discard model (Figure 8.20). Composite implements, finished tools and cores, and expedient tools, primarily made on large primary and secondary flakes were introduced into the site. While onsite, microblade insets were removed and discarded and microblades were produced for composite implements and some were used and discarded onsite. Microblade cores, core parts, and other debitage (including microblades) were produced and discarded. Bifacial and unifacial tools were maintained and used onsite and some large flakes were used as expedient tools. Some of the bifaces, unifaces, and expedient flakes were discarded on site, and others were removed from the site, along with composite implements and microblade insets. Note, the differences between inset replacement and inset production are examined in Chapter 10.

Given the spatial organization of the various components, in terms of lithic concentrations interspersed with hearth features and faunal clusters, Gerstle River Component 3 likely functioned as a field camp (see Binford 1980:347), where tools were maintained and recently dispatched game was processed. The mixture of two primarily different tasks are reflected in the assemblage, with highly curated tools (e.g., burins, one short axis beveled flake) and microblades produced from curated microblade cores co-occur spatially with expediently formed implements like modified flakes and spall scrapers for faunal processing. A camp described in these terms would not likely be characterized as a residential base camp, where a wider variety of tools and a greater accumulation of debris would be expected. This pattern suggests two alternative explanations, (1) Early Holocene populations may have had relatively lower logistical mobility and much higher residential mobility compared to more recent populations in Alaska (Binford 1978b), or (2) components like Gerstle River Component 3 represent short term field camps to support hunting parties away from their residential base camps (Guthrie 1983a) and that the known sites in this time period reflect only a portion of the site organizational variability for this time period. Given current data, I cannot choose between either model.

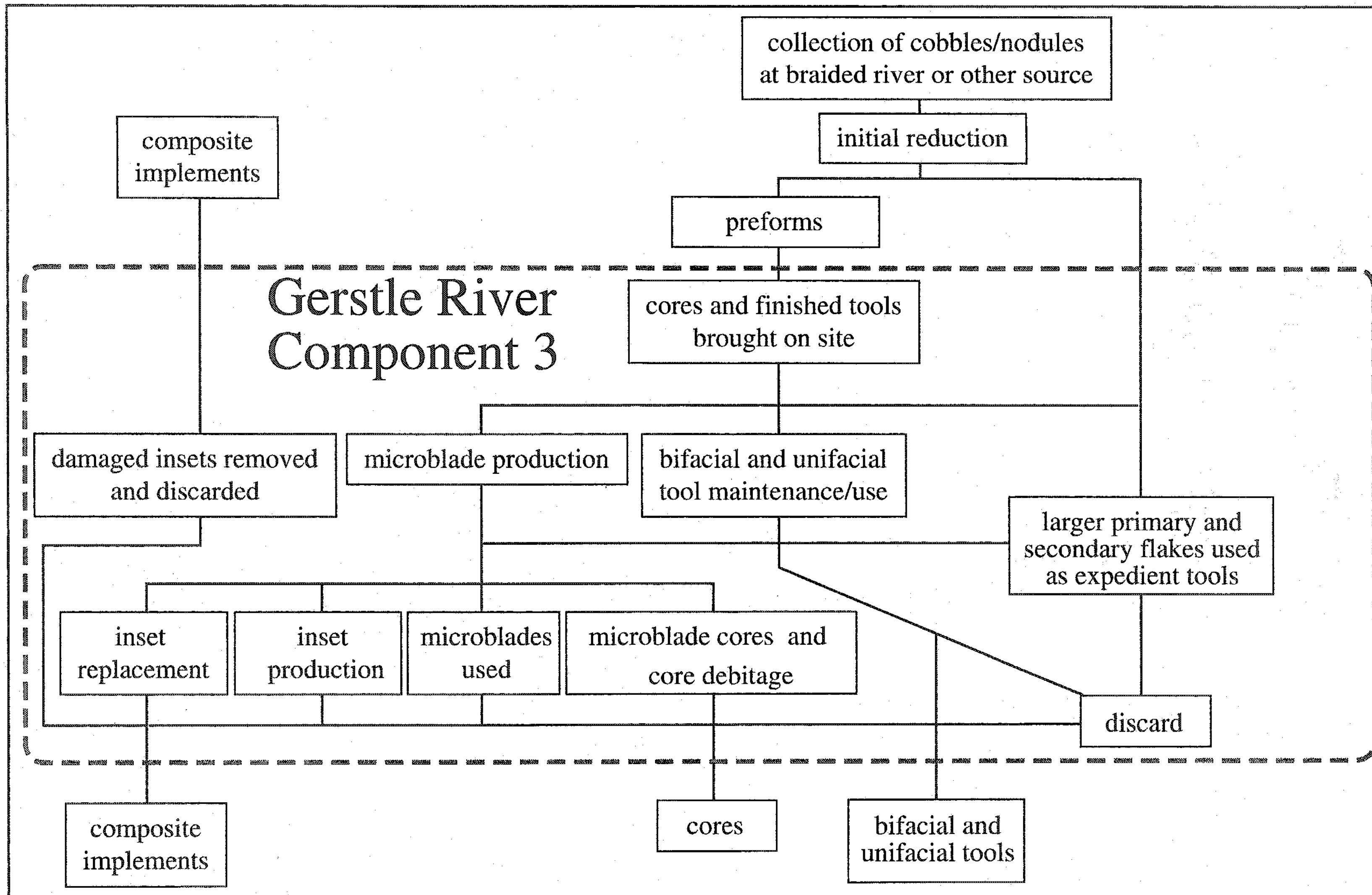


Figure 8.20 Component 3 lithic reduction, use, and discard model.

CHAPTER 9. CULTURAL FEATURES

Introduction

This chapter provides detailed descriptions of all cultural features identified during the 1999-2004 excavations at Gerstle River Lower Locus and the results of flotation and macrofossil analysis on four sampled features from Component 3. These include all features found to date at the Lower Locus. As noted above, hearth features and faunal concentrations were likely present at the Upper Locus in Grid A and Grid G, but no site reports exist for these data. The features are presented here in order of component age, Component 2 (Features 2, 17, and 19), Component 3 (Features 1, 3, 5, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18), and Component 4 (Feature 7). No features were found in association with Component 5. Components 6 and 7 were present only at the Upper Locus, and no artifacts were encountered in these strata (Y2 and Y1 respectively) during this investigation.

Features are defined here as remnants of past human activities that cannot be removed without destroying their integrity. In this fashion, a cluster of fauna or lithics, once provenienced and carefully mapped in three dimensions, are not considered features. These patterned remains are examined in Chapters 6 and 10 respectively.

Terminology is defined here for the purpose of clarity and definition. *Hearths* (n=13) are defined here as discrete localities of oxidized sediment containing numerous charcoal fragments directly associated with lithic material. These hearths (in Components 3 and 4) also contain burned and unburned faunal fragments and lithic artifacts, but these are not necessary for the definition. Hearths as defined here are interchangeable with *firepits*. Hearths may have associated cobbles or not, they may be clay or rock-lined or unlined. Aside from hearths, the only other oxidized areas at the site were the widespread continuous and discontinuous buried Bw horizons (strata R1-R5). None of these strata have associated cultural remains or faunal remains. *Charcoal scatters* (n=2) are defined here as discrete clusters of charcoal fragments. In general, charcoal was not found in stratum Y4a or Y4b except within or near hearths and charcoal scatters.

As ethnographic research shows, and the spatial patterning at Gerstle River indicates, hearth features can function as focal points within a site (Binford 1978b, 1983, 1987; Stevenson 1985; O'Connell 1987). The lithic and faunal debris at Gerstle River Components 2, 3, and 4 exhibit clustering with respect to hearths (see Chapter 10). A defining characteristic of hearths, and of features in general, is that they are generally immobile once initiated, and behavior at a camp site is often situated relative to them. Therefore, understanding the function of the Gerstle River hearths is a critical step in understanding site use and interpreting the spatial patterning of artifacts and faunal remains through the components. Given the relative lack of detailed descriptions of open hearths in the Alaskan record for the early Holocene, considerable attention is devoted in this section to provide data on feature size and morphology, as well as data on faunal remains found directly within the features. Additional attention is afforded to the potential for variability in these features. These data are compared with expectations from the ethnographic record in order to assess the function of these features within the components. The descriptions detailed in this chapter form platforms from which to examine various dimensions of site organization and structure developed in Chapters 10 and 11.

Five classes of features are defined at Gerstle River, Components 1 through 4. The most common type is a discrete oxidized lens with embedded charcoal fragments, defined here as hearths or firepits (n=13). Another type of feature is a charcoal scatter directly associated with artifacts spatially and stratigraphically, but lacking a clear oxidized lens (n=2, Features 8 and 11). Within Feature 8, the surrounding sediments are gray in color, with numerous tiny particles of charcoal within the weakly mottled loess matrix. Within Feature 11, no gray stained sediments are associated. A third type consists of cobble features, of which one was identified at the site. Feature 19 is a small cluster of cobbles situated in a circle, within which lay numerous lithic debitage. The fourth feature type consists of Feature 15, stratigraphically associated with Component 3. Feature 15 is a relatively large compressed burnt log with no oxidized sediment or associated lithic scatter, but with faunal fragments in direct association. The fifth feature type consists of two features, Features 20 and 21 consisting of very small circular bright reddish stains with no charcoal associated with artifacts.

Other types of features could be described at Gerstle River, including faunal and lithic clusters, but these require aggregation and examination under very different considerations than the immobile features described above. The latter can be considered site furniture, or the focus around which activities took place. The faunal and lithic clusters are analyzed in detail in Chapters 6 and 10.

Methods

Physical descriptions are made for each feature. Variables include size, plan-view and cross section shape, boundary type (clear, diffuse, smeared), relative charcoal quantity (rich or poor), size of charcoal particles, position of charcoal particles (top, bottom, mixed), oxidization (strong or weak), faunal types within hearth (calcined, burned, unburned), sizes of faunal remains in hearth (and fragmentation types). Inferences are made about degree of preservation and evidence of reuse for each feature. Specific results of flotation and macrofossil analysis are presented for four hearths in Component 3 (one each from Area A, B, C, and D).

Estimated surface area in plan view is derived from the formula for area of an ellipse. To facilitate analysis of associated faunal remains, an analytical surface area was estimated on the basis of 0.25 m^2 quads directly associated with the features. I was conservative in assigning quads to each feature, as only the fauna directly within the features was necessary. Therefore, the analytical areas generally underestimated the surface area by 0.54±0.34 m^2.

Various faunal summaries and characteristics were recorded for each associated feature. Number of provenience units relate to discrete proveniences of fauna (i.e., larger remains are separated by accession and smaller within a tiny area are grouped by catalog number [see Chapter 6]). Faunal remains for each feature were quantified by selecting all 3-pointed faunal remains directly within the features and all screened faunal remains within the 0.25 m^2 quads directly associated with the features. It is possible that some smaller sized faunal fragments not directly within the hearth may be sampled as well in the screened samples, but these fragments are within about 25 cm of each feature. Large fauna clearly outside the features outer edges were removed from further analysis.

In order to operationalize faunal fragment counts (avoiding the restrictions of NISP), *number of fragments* is derived from a total count of those fragments greater than 0.3 cm in maximum dimension for each provenience unit. When original observation notes indicate "many" fragments, the number of fragments is estimated at 30 if total weight of the lot is ≥0.2 g, and 1 if total weight of the lot is <0.2 g (see Chapter 6).

Total weights include all faunal weights within the feature boundaries. Faunal remains weighing less than 0.1 g are listed as 0.1 g. To quantify and compare sizes of faunal particles among features, mean (±1 σ) and median weights are provided per provenience unit and mean weight per fragment is obtained for each feature. Similarly, faunal density is estimated by dividing number of fragments (fragment density) and total weight (weight density) by analytical area.

Fragmentation of the faunal remains is quantified by measures of the maximum dimension on each provenience unit. The maximum dimension (of all provenience units per feature) and the mean and median maximum dimension (per provenience unit) are listed. Faunal shape and burning types are listed by both total weights and total number of fragments. Faunal shapes consist of unidentified, long bone, flat bone, irregular bone, and teeth/enamel. Burning types consist of calcined, black charred, brown charred, possibly burned (discolored), not burned, reddened, and indeterminate. Identified specimens by taxon, element, and side are listed for each feature. In addition, size class data are provided.

Tabular summaries of analytical area, faunal fragments and weight, and weight and density statistics for the features in Components 3 and 4 are provided in Table 9.1 (Component 2 features and Component 3 Feature 11 are not associated with any faunal remains). Table 9.2 lists faunal shape for each feature and Table 6.3 lists burning types for each feature. Plan views of hearths including all faunal remains, lithic tools and debitage, charcoal, and stained sediments are illustrated in various figures. Figure 9.1 provides a key for symbols used in these figures.

Four features were selected for flotation and macrofossil analysis: Hearth Features 5, 10, 12, and 14, one from each area of Component 3. I contracted Carol Gelvin-Reymiller to conduct the flotation and macrofossil analysis (Gelvin-Reymiller 2004). Methods for flotation followed Pearsall (1989). The entire matrix of each feature underwent flotation. The results are summarized for each of the four features below.

Feature reuse is estimated on the basis of a number of characteristics. Chatters described three proxy indicators of mobility frequency: debris accumulation, sizes of thermally altered rock, and feature discreteness (1987:344-347). While thermally altered rocks are rare in this assemblage, the nature, density, and diversity of lithic and faunal concentrations associated with one or more features can be assessed. Feature discreteness is based on integrity of the charcoal and oxidized lens distribution and dispersal and peakedness of the associated artifact concentrations.

Table 9.1. Feature summary table, faunal fragments, weight, and density.

Feature	*Estimated Area (estimated total area) (m^2)*	*Analytical Area (m^2)*	*Total fauna fragments*	*Total fauna wt (g)*	*Mean wt (per frag.)*	*Fragment density (n frags/m^2)*	*Weight density (g/m^2)*
			Component 3 Features				
1*	1.14	0.75	31	359.3	11.6	41	479.1
1†	1.14	0.75	26	145.7	5.6	35	194.3
3*	1.37 (1.53)	1.00	220	67.3	0.3	220	67.3
5*	2.29	1.00	192	105.3	0.5	192	105.3
8	6.32	2.00	52	215.4	4.1	26	107.7
9	1.43	0.75	2	1.8	0.9	3	2.4
10*	1.93	1.75	244	241.2	1.0	139	137.8
12*	1.98	1.25	92	181.0	2.0	74	144.8
13	2.11	1.50	7	32.2	4.6	5	21.5
14*	1.74 (1.88)	1.00	140	77.4	0.6	140	77.4
15	1.06	1.50	2	16.7	8.4	1	11.1
16	1.26 (2.01)	1.25	23	240.4	10.5	18	192.3
18	1.26 (2.00)	0.75	53	75.4	1.4	71	100.5
avg. hearth	1.83	1.10	101	164.5	3.3	78	120.6
avg. proc. hearth*	1.79	1.13	154	215.8	2.7	134	168.6
avg. other hearth¥	1.89	1.06	21	87.5	4.3	24	79.2
			Component 4 Feature				
7	3.47	1.50	130	65.4	0.5	86.7	43.6

* hearths associated with processing areas
¥ hearths not associated with processing areas
† Feature 1 without the articulated vertebrae (UA99-62-288).

Table 9.2. Feature summary table, faunal shape[1]

Feature	unid. Wt.	unid. %	long wt.	long %	flat wt	flat %	irreg. Wt.	irreg. %	teeth wt.	teeth %
Component 3 Features										
1*	12.9	4	124.2	35	0	0	213.6	59	8.6	2
1†	12.9	15	124.2	85	0	0	0	0	0	0
3*	52.5	78	14.8	22	0	0	0	0	0	0
5*	45.2	43	60.1	57	0	0	0	0	0	0
8	26.5	12	188.9	88	0	0	0	0	0	0
9	1.8	100	0	0	0	0	0	0	0	0
10*	119.9	50	108.4	45	12.4	5	0	0	0.5	0
12*	62.8	35	103.1	57	14.5	8	0	0	0.6	0
13	14.2	44	17.8	55	0	0	0	0	0.2	1
14*	18.8	24	29.8	39	0	0	28.8	37	0	0
15	1.5	9	15.2	91	0	0	0	0	0	0
16	0.9	0	206	100	0	0	0	0	0	0
18	2.9	4	72.4	96	0	0	0	0	0.1	0
avg. hearth	33.2	32	97.9	56	2.7	1	26.3	10	1.0	0
avg. proc. hearth*	52.0	29	113.8	52	4.5	2	43.9	17	1.6	0
avg. other hearth¥	5.0	37	74.1	63	0	0	0	0	0.1	0
Component 4 Feature										
7	20.6	31	44.8	69	0	0	0	0	0	0

* hearths associated with processing areas
¥ hearths not associated with processing areas
† Feature 1 without the articulated vertebrae (UA99-62-288).

[1] Note: unid., unidentified bone fragment, long, long bone fragment, flat, flat bone fragment, irreg., irregular bone fragment, teeth, teeth/enamel fragments (and associated mandibular or maxillary bone), wt is in grams.

Table 9.3. Feature summary table, faunal fragments, burning type[2]

Feature	calc. wt	calc. %	black wt	brown %	brown wt	brown %	un-burn. wt	un-burn. %	red. Wt	red. %	indet. wt	indet. %	burn wt	burn %
Component 3 Features														
1*	0.4	0	8.1	2	213.6	59	137.2	38	0	0	0	0	213.6	59
1†	0.4	0	8.1	6	0	0	136.6	94	0.6	0	0	0	8.1	6
3*	24.0	36	0	0	0	0	43.3	64	0	0	0	0	24.0	36
5*	5.5	6	12.8	15	5.6	7	60.2	72	0	0	0	0	23.9	28
8	0.1	0	0	0	0	0	215.3	100	0	0	0	0	0.1	0
9	0	0	0	0	0	0	1.8	100	0	0	0	0	0	0
10*	63.2	26	0.8	0	0	0	176.7	73	0	0	0.5	0	64.0	27
12*	0	0	22.3	12	4.1	2	154.6	85	0	0	0	0	26.4	15
13	0	0	0	0	0	0	32.2	100	0	0	0	0	0	0
14*	0.3	0	3.9	5	4.6	6	67.6	87	1	1	0	0	9.8	13
15	0	0	0	0	0	0	16.7	100	0	0	0	0	0	0
16	0.4	0	0	0	0	0	239.6	100	0	0	0	0	0.8	0
18	0	0	0.1	0	0.1	0	74.3	98	0.9	1	0	0	1.1	1
avg. hearth	8.9	4	5.3	4	22.8	7	98.8	82	0.2	0	0.1	0	36.4	15
avg. proc. hearth*	14.7	6	8.9	6	38.0	12	106.8	70	0.2	0	0.1	0	60.3	25
avg. other hearth¥	0.1	0	0.0	0	0.0	0	87.0	99.6	0.2	0	0.0	0	0.5	0.4
Component 4 Feature														
7	0.4	1	64.9	99	0	0	0.1	0	0	0	0	0	65.3	100

* hearths associated with processing areas
¥ hearths not associated with processing areas
† Feature 1 without the articulated vertebrae (UA99-62-288).

[2] Note: calc., calcined, black, black charred, brown, brown charred, poss., possibly burned, not burn., unburned, Red., reddened, Indet., indeterminate, wt is in grams.

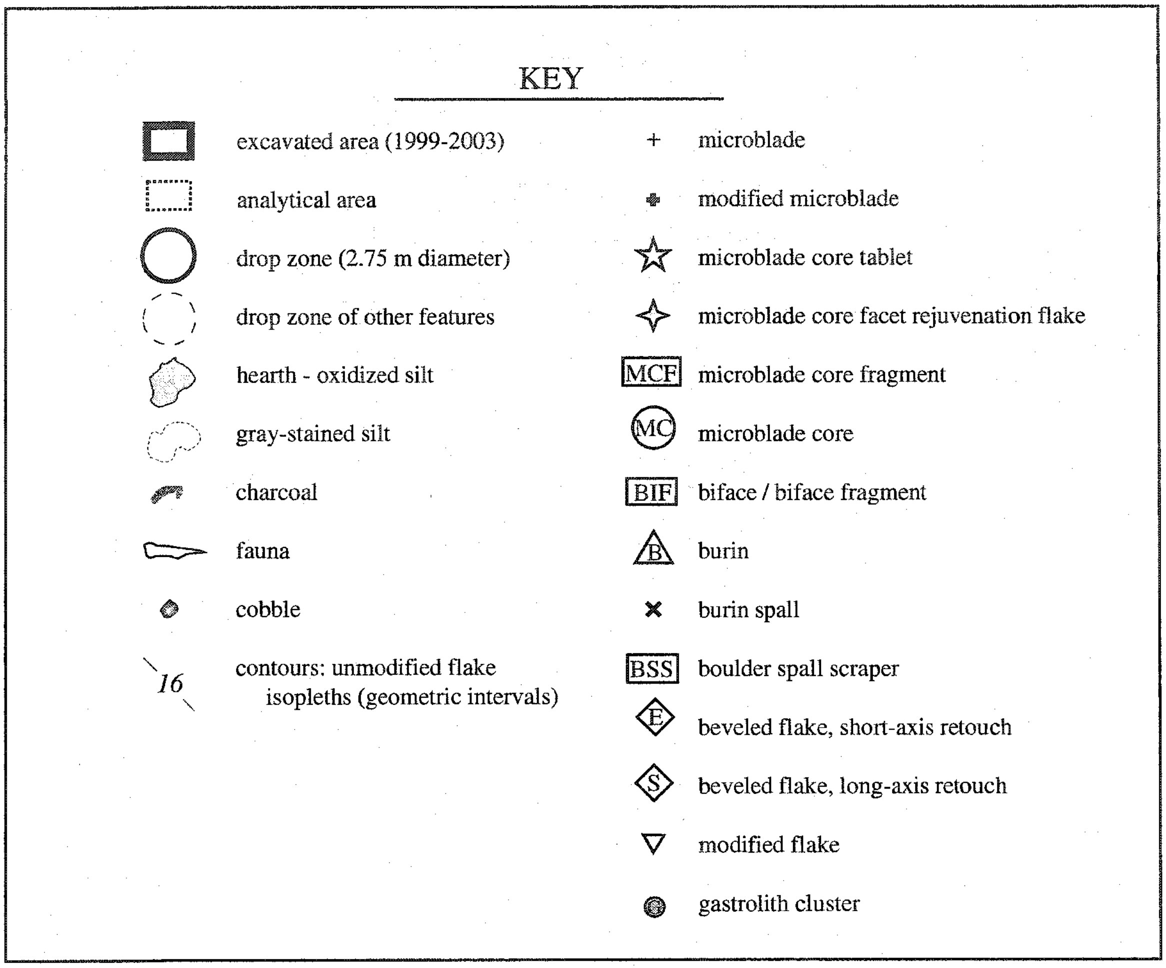


Figure 9.1 Key for feature plan views.

Cultural Feature Descriptions

Component 2 Features

Three features were recovered within Component 2 (Figure 9.2). Feature 2 was a hearth feature within Excavation Block B. Features 17 and 19 were a hearth feature and a cobble feature respectively, both within Block Y. All were in association with artifacts, and all were at the same stratigraphic position, about 10 cm below R5 within Y4b.

Feature 2 (hearth)

Feature 2 is a sub-circular hearth, defined by a discrete oxidized loess lens with charcoal fragments and burned lithics (Figures 9.3-9.5). Feature 2 is 73 cm across along its widest axis (northeast to southwest) and 35 cm across along its shortest axis (northwest to southeast), with a surface area of about 0.80 m^2. Cross section is approximately lenticular, with a maximum thickness of about 4 cm (Figure 9.4). No cobble fragments or bones were found in association with the hearth. A few small angular to sub-angular pebbles (< 1 cm diameter) were found within the hearth. Two charcoal clusters are apparent, one in the center and one at the western edge.

The boundary for this feature is clear, and no evidence of smearing is present. The oxidization is considered moderate relative to the other hearths, and the outer edge is discrete. Compared with the other hearths, this hearth is relatively charcoal poor. No other features were observed near it, and no large charcoal fragments were found outside of this hearth in stratum Y4b. Two 3-pointed charcoal samples from within the feature were collected, and the hearth matrix was catalogued in two bags. All sediment, charcoal, etc. within the oxidized lens was collected. The size of the charcoal fragments was small, less than 5 cm in maximum dimension. Charcoal from within one of the matrix bags yielded a date of 9510±50 BP (β-134098). The charcoal fragments were scattered throughout the hearth. Since no faunal remains were found associated with the hearth, no analytical area was estimated. The lithic Subarea E was directly associated with this hearth. Rhyolite and chert microblades and flakes with evidence of heat damage (crazing, pot-lidding) were found within and near Feature 2. However, these materials

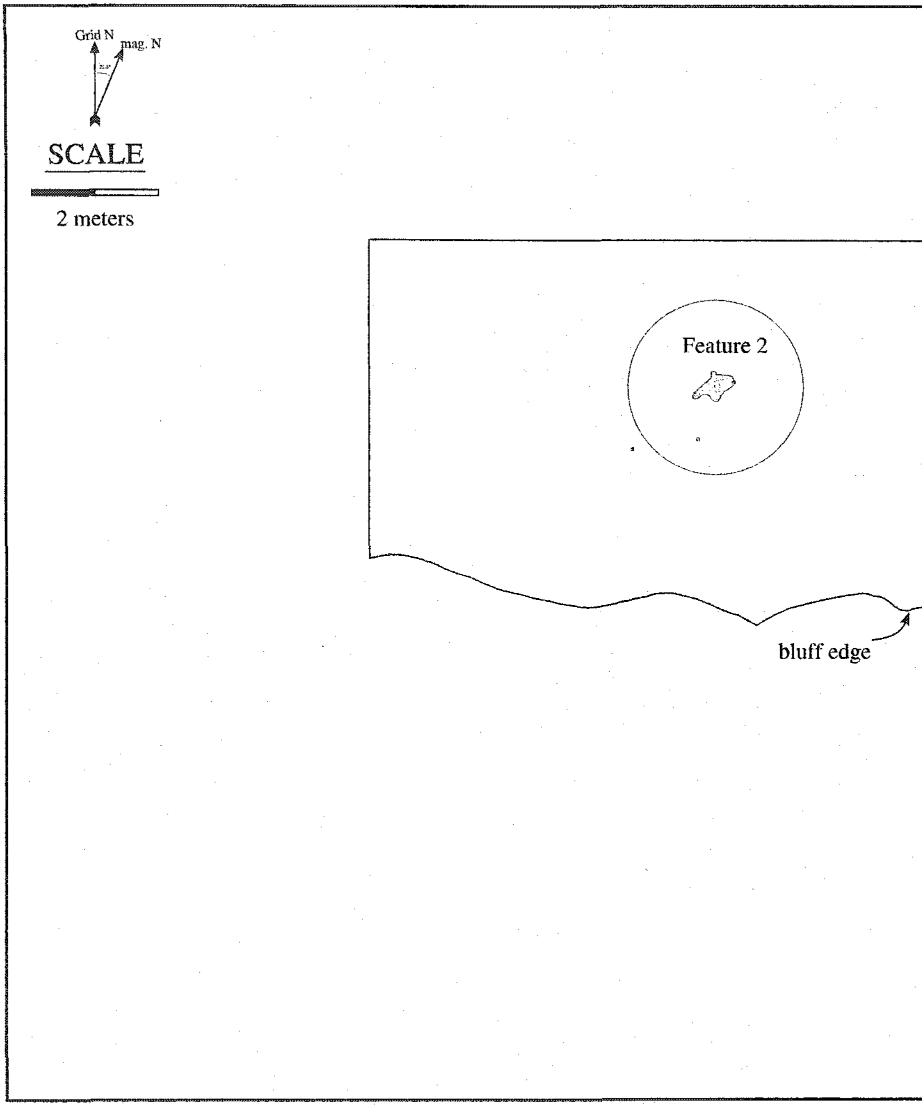
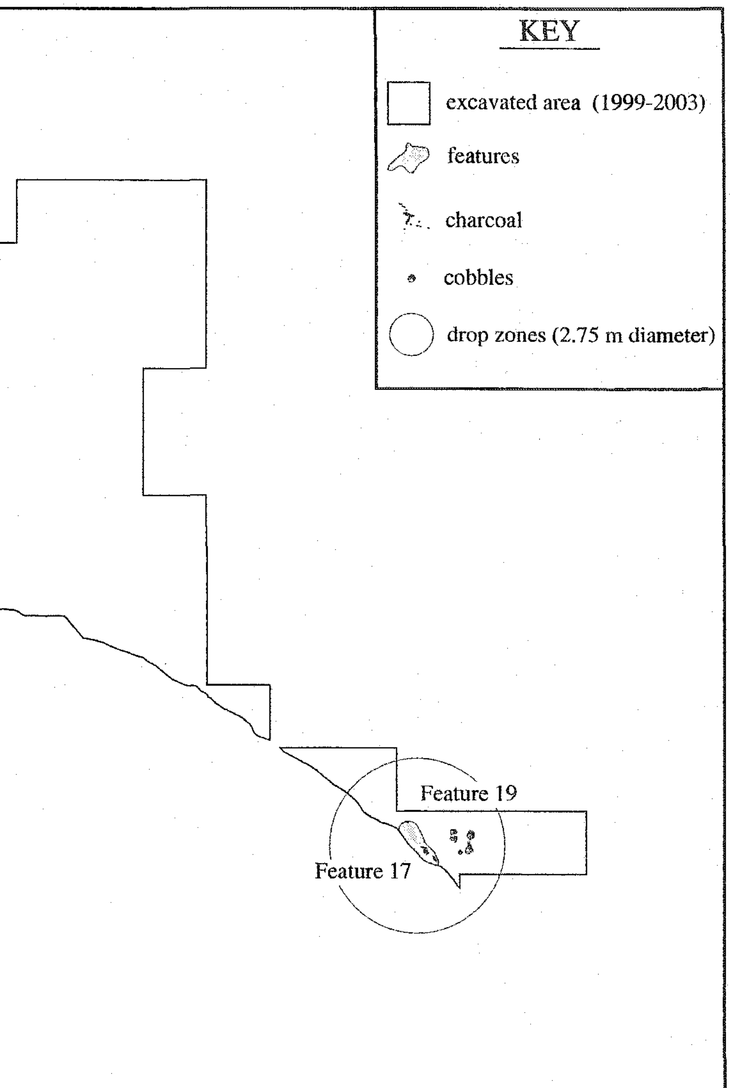


Figure 9.2 Component 2 features plan view.


KEY
excavated area (1999-2003)
features
charcoal
cobbles
drop zones (2.75 m diameter)
Feature 19
Feature 17

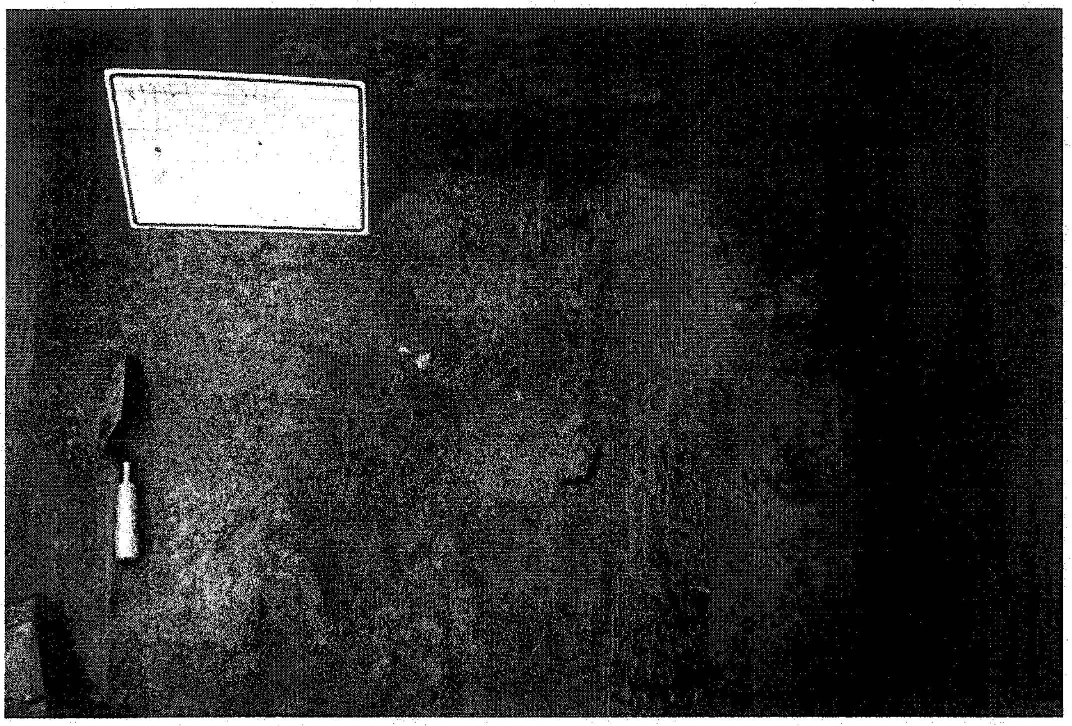


Figure 9.3 Feature 2 plan view, grid north at top of image (note rhyolite flakes in hearth).

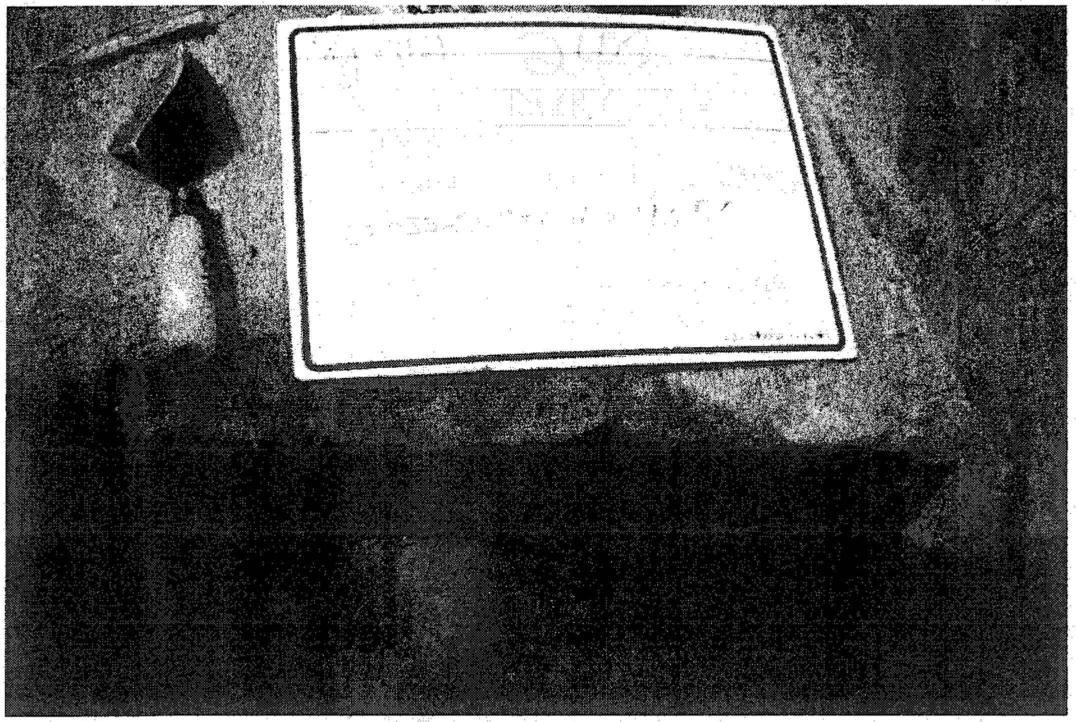


Figure 9.4 Feature 2, cross section, view grid west.

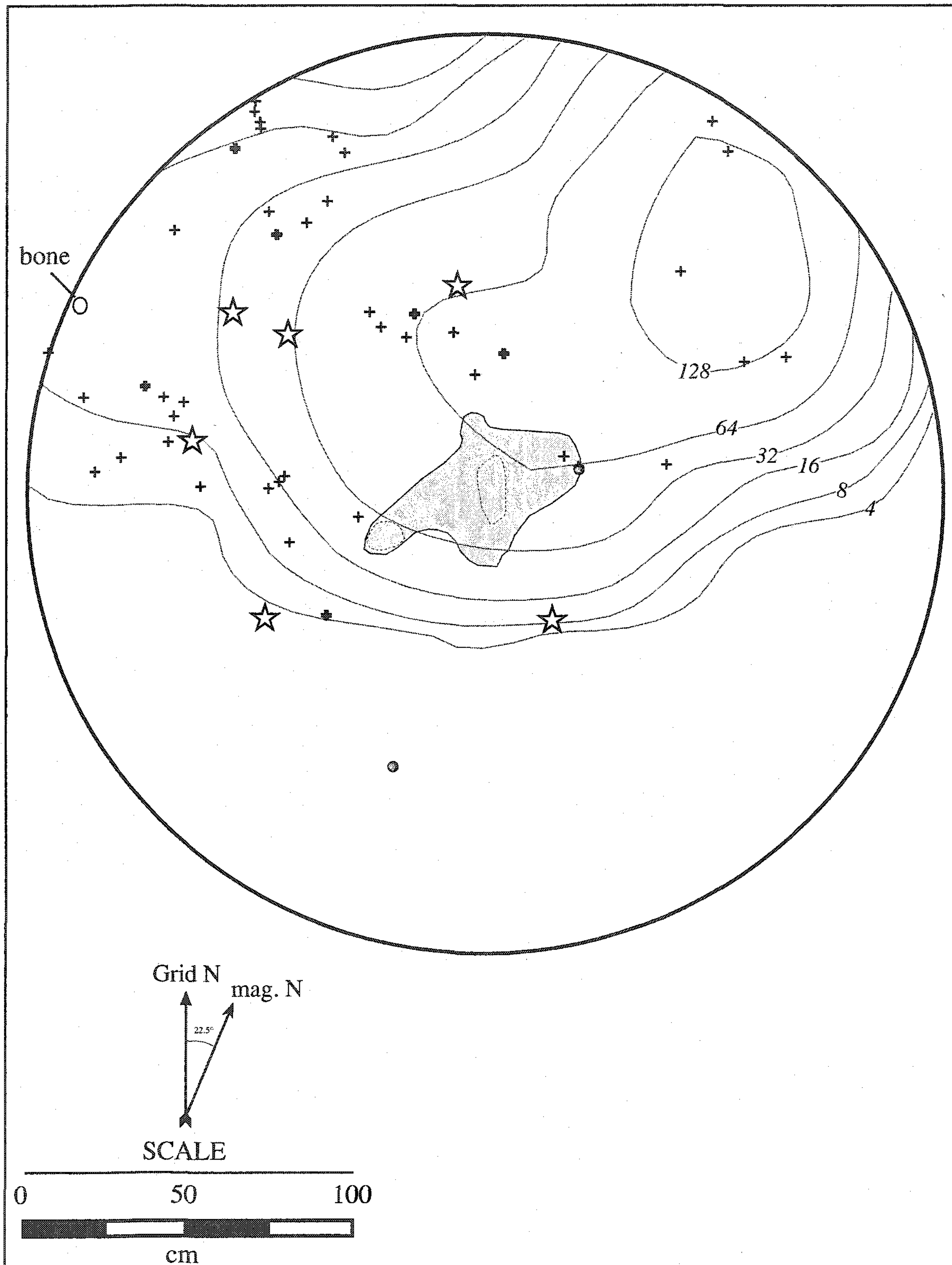


Figure 9.5 Feature 2 plan view.

were fine grained with few irregularities of inclusions, and since the majority of these materials were not heat-altered, heat treatment was likely not an objective.

The distribution of lithic debitage shows clustering to the northeast of Feature 2, however the microblade distribution shows clustering to the north and northwest, suggesting two possible flintknapping events. Five microblade core tablets are present in the western cluster (see Chapters 7, 8, and 10). A number of retouched microblades are present near Feature 2, but no other tools are in the vicinity. On this basis, the feature is interpreted to have been used while microblade core rejuvenation, microblade manufacture, and tool maintenance occurred.

Reuse of Feature 2 is considered unlikely given the few lithic raw material types with greater than 5 specimens (n=4), the relatively small size of the lithic assemblage in Subarea E (n=488), the close spatial clustering of the lithics, the lack of other features in the vicinity, and the lack of hearth smearing.

Feature 17 (hearth)

Feature 17 is a hearth, defined by a discrete oxidized loess lens with charcoal fragments, hearthstones, and nearby lithics (Figures 9.6-9.7). Feature 17 is 85 cm across along its longest axis (northwest to southeast) and 25 cm across along its shortest axis (northeast to southwest). Both measurements should be seen as minima, as the feature is truncated by the eroding bluff edge. These measurements yield a minimum surface area of 0.67 m^2, though it may be as high as 2 or more m^2 originally. The cross section is lenticular, with a maximum thickness of 8 cm, thinning toward the edges. A cobble was found directly within the hearth, and a spall scraper was found directly adjacent to the hearth to the east.

The boundary for this feature is clear, and no evidence of smearing is present, though a portion of it eroded prior to excavation. Feature 19, a cluster of cobbles arranged in a circle, was present about 40 cm to the east from the eastern edge of Feature 17. Two 3-pointed charcoal samples from within the feature were collected, one yielding a radiocarbon date of 9400±50 BP (β-183110). The hearth matrix was catalogued in one bag. The size of the charcoal fragments was up to 5 cm in maximum dimension. The charcoal fragments were scattered throughout the hearth. Since no faunal remains were found associated with this hearth, no analytical area was

Figure 9.6 Feature 17 plan view and cross section, view grid north.

estimated. The lithic Subarea F was located to the east of Feature 17, though some were found within the hearth.

The lithic debitage distribution shows relatively few flakes near Feature 17. The only tools nearby include a spall scraper, an short axis beveled flake fragment, and two modified flakes. The debitage is all of one material type, different from these tools, and are quite small, suggesting tool maintenance rather than core reduction. No faunal remains were located in the immediate area, suggesting that the feature was used in the course of tool maintenance.

Reuse of Feature 17 is considered unlikely given the few lithic raw material types (n=2), the relatively small size of the lithic assemblage in Subarea F (n=340), the close spatial clustering of the lithics, the lack of other hearth features in the vicinity, and the lack of hearth smearing.

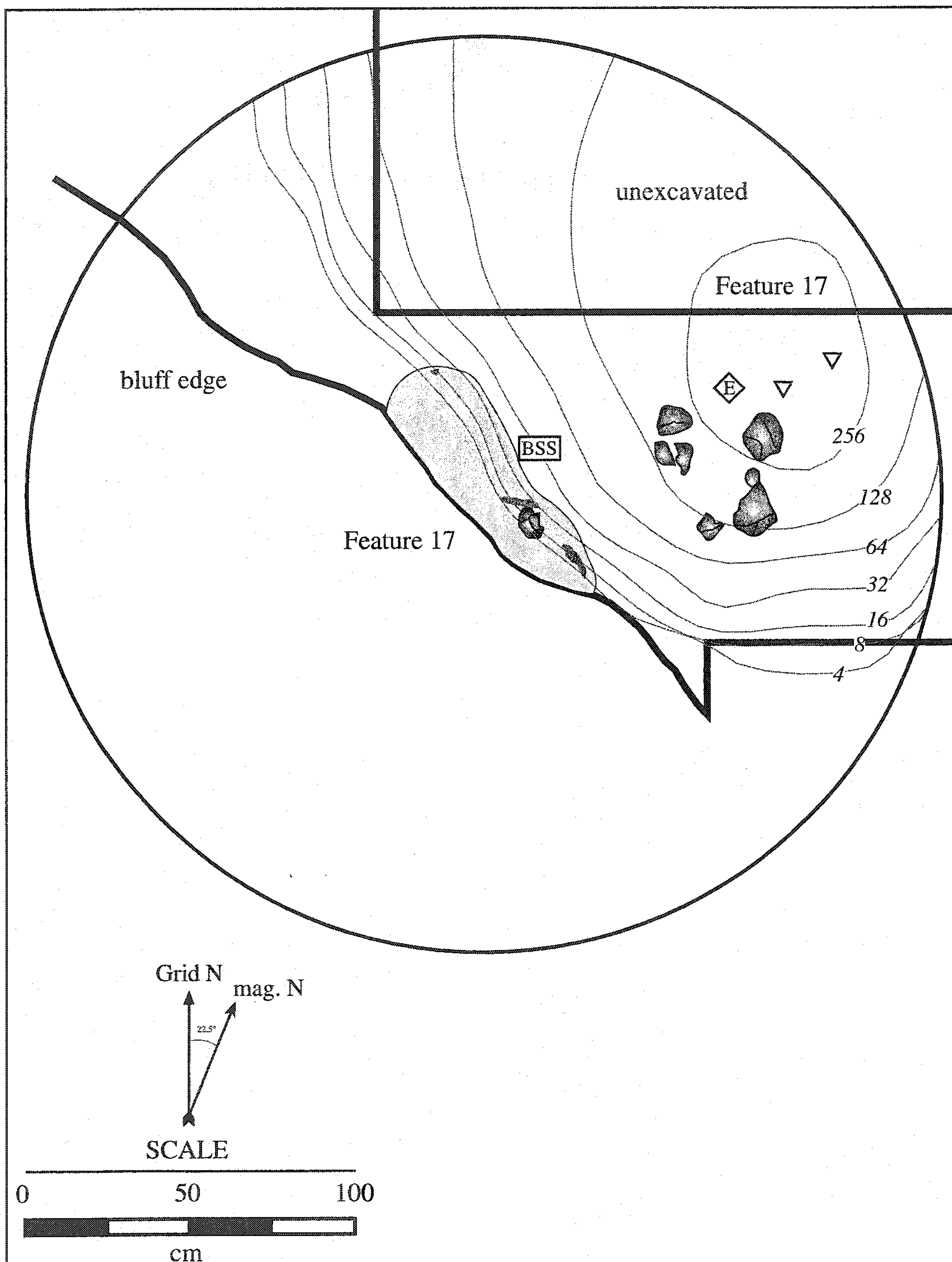


Figure 9.7 Feature 17 and 19 plan views.

Feature 19 (cobble cluster)

Feature 19 consisted of seven cobbles, ranging in size from 6 to 16 cm in diameter, arranged in a circle with an inner diameter (open space between cobbles) ranges from 20-25 cm and an outer diameter (from outer edges of the cobbles) of 45 cm (Figures 9.7-9.9). The cobbles ranged from 28.7 to 1697.1 g in weight. All are angular granite, and probably derived from the local bedrock. The rocks were placed in a rough circle, with a dense concentration of debitage located within. There was no clear oxidization of the sediment within Feature 19, and no charcoal; therefore, a fire was probably not contained by these cobbles. The rocks may have been heated and placed into this position for heat-treatment of the lithic raw materials, however, the lithic raw material within Feature 19 did not show heat damage and were similar condition to those lithic raw materials outside of this feature within the stratum Y4b. Two of the seven cobbles (UA2003-54-1295 and 1297) have surfaces that may be thermally altered (reddened). The cobbles may have functioned as a marker for a cache of items, later removed. No other cobbles of this size were found in stratum Y4b except for one other directly within Hearth Feature 17, about 40 cm to the west.

Due to the presence of the dense cluster of flakes within Feature 19, and for expediency, the northwest quad of EUN42E54 was divided into four 25 x 25 cm units (0.0625 m^2 each) for screening. The 25 x 25 cm unit directly within the feature yielded 161 flakes versus 53, 21, and 5 for the other four units of EUN42E54 (Figure 9.9). A total of 341 lithic items were found in association with Features 17 and 19, with 317 (93%) found within Feature 19 or within 50 cm of it (see Figure 9.7). Most of the lithic raw material (n=329) is Qa1, gray quartzite, and 11 specimens are C6, gray chert. The large quantity of one material type, Qa1, is interesting, perhaps suggesting that this feature was in some way related to the manufacture of one or more tools from this raw material. Items associated with Feature 19 (Subarea F) include one short axis beveled flake fragment, two modified flakes, a spall scraper, and 336 unmodified flakes. A single enamel fragment was located within Y4b about 2.2 m to the east, and thus not in close association with Feature 19.

Reuse of Feature 19 is considered unlikely given the few lithic raw material types (n=2), the relatively small size of the lithic assemblage (n=329), the close spatial clustering of the lithics, and the lack of scattering of the cobbles.

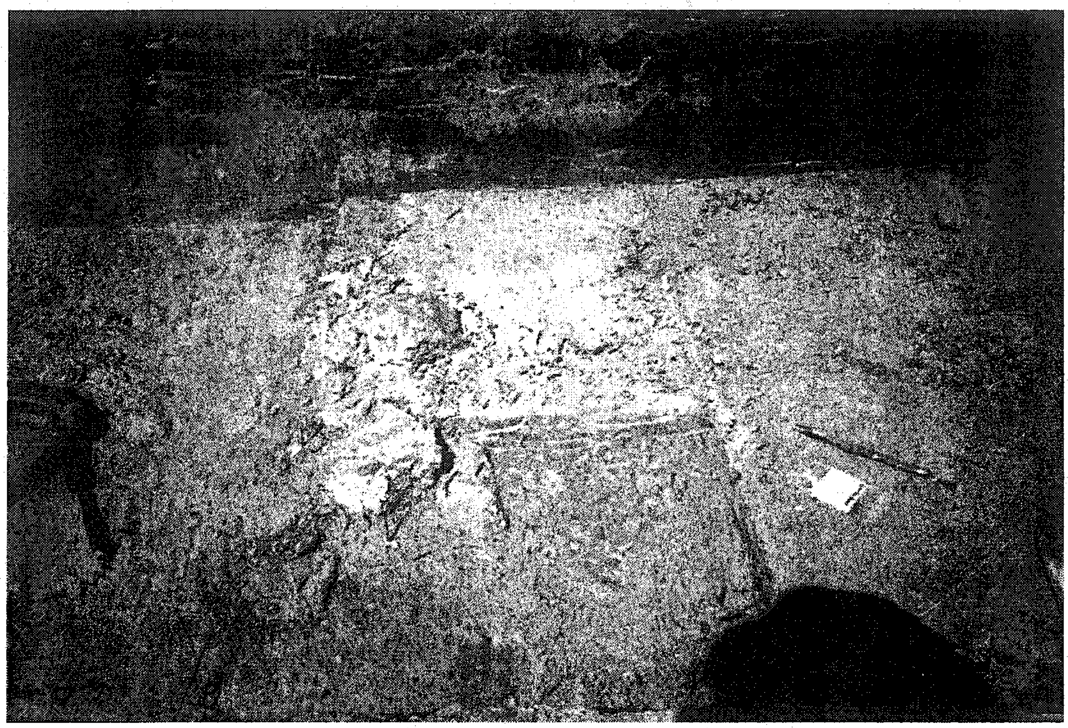


Figure 9.8 Feature 19 plan view, view grid north.

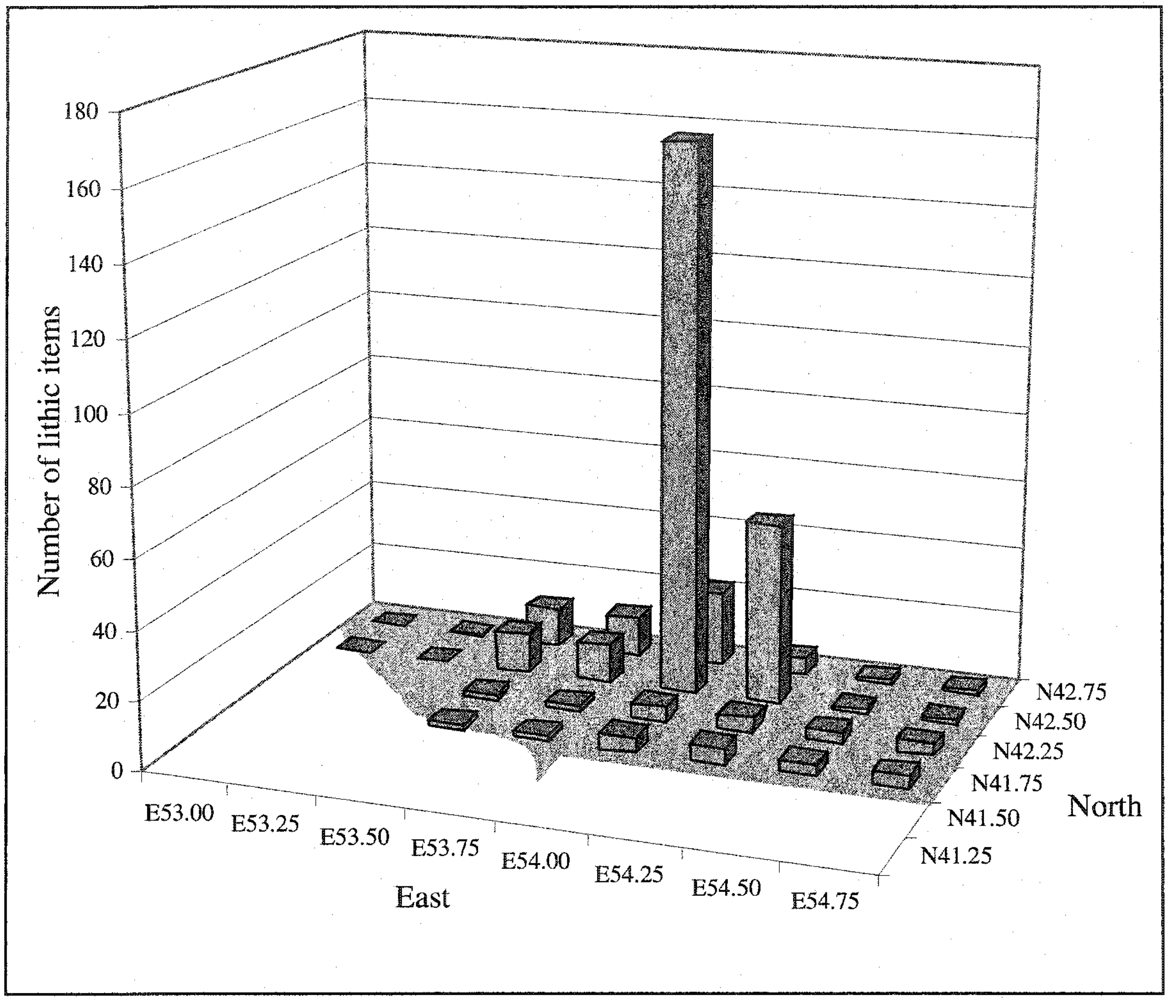


Figure 9.9 Area F lithic distribution in 25 x 25 cm units (excavated area in gray). Note peak at N42.50-42.75, E54.00-54.25, coinciding with center of Feature 19.

Component 3 Features

A total of 15 features were identified within Component 3, i.e., within Y4a between R4 and R5 (Figure 9.10). To date, there are 10 discrete hearth features, two charcoal scatters directly associated with artifacts, one burnt and compressed tree trunk or large limb in association with large mammal remains, and two small circular reddish stains. Each of these features were located at the exact same level as the artifacts within Component 3, and all except Feature 15 have numerous lithic tools and debitage directly associated within their matrix.

Features 1, 3, 5, 9, 10, 12, 13, 14, 16, and 18 were discrete hearth features, with clear boundaries of oxidized loess and numerous charcoal fragments. Features 3, 14, and 16 were discovered eroding from the bluff edge, and their measurements should be considered minima. Feature 18 was partially excavated, with an estimated 30% still *in situ*. The remaining six hearths were excavated completely. The associated oxidized lenses were all lenticular in shape, and charcoal was scattered throughout the oxidized area. Cross sections were available for all features, and these consistently indicate maximum thickness near the centers, narrowing to the edges of the oxidized lenses. These oxidized lenses were limited in plan view, and were generally less than one meter in lateral aspect. The hearths were very similar to one another in plan view, and no elongation or other form suggesting post-depositional disturbance was apparent. Discussion of various characteristics of these hearths is provided below.

Features 8 and 11 were characterized as charcoal scatters in direct association with the artifacts. It was thought during excavation (in 2001) that these may have been hearths that for taphonomic reasons did not have an oxidized lenses associated with them; given that they were found in the extreme north and northeast part of the excavation (at that time), where the sediment column was thinner. However, the presence of larger hearths with oxidized lenses identical to the others at the site (Features 12 and 18) in subsequent years suggested that these two features were charcoal that may have been displaced from a larger hearth area (Feature 8 derived from Feature 12 or 18, Feature 11 possibly derived from a hearth that may lie north in the unexcavated area).

Feature 15 was dissimilar to all other features found within Component 3. It appeared to be a large compressed charcoal fragment (trunk or large limb) associated with large mammal bones within Y4a (i.e., Component 3). Very few lithics were found in this area, and it was located on the slope below the main occupation area (Area B, see Chapter 10).

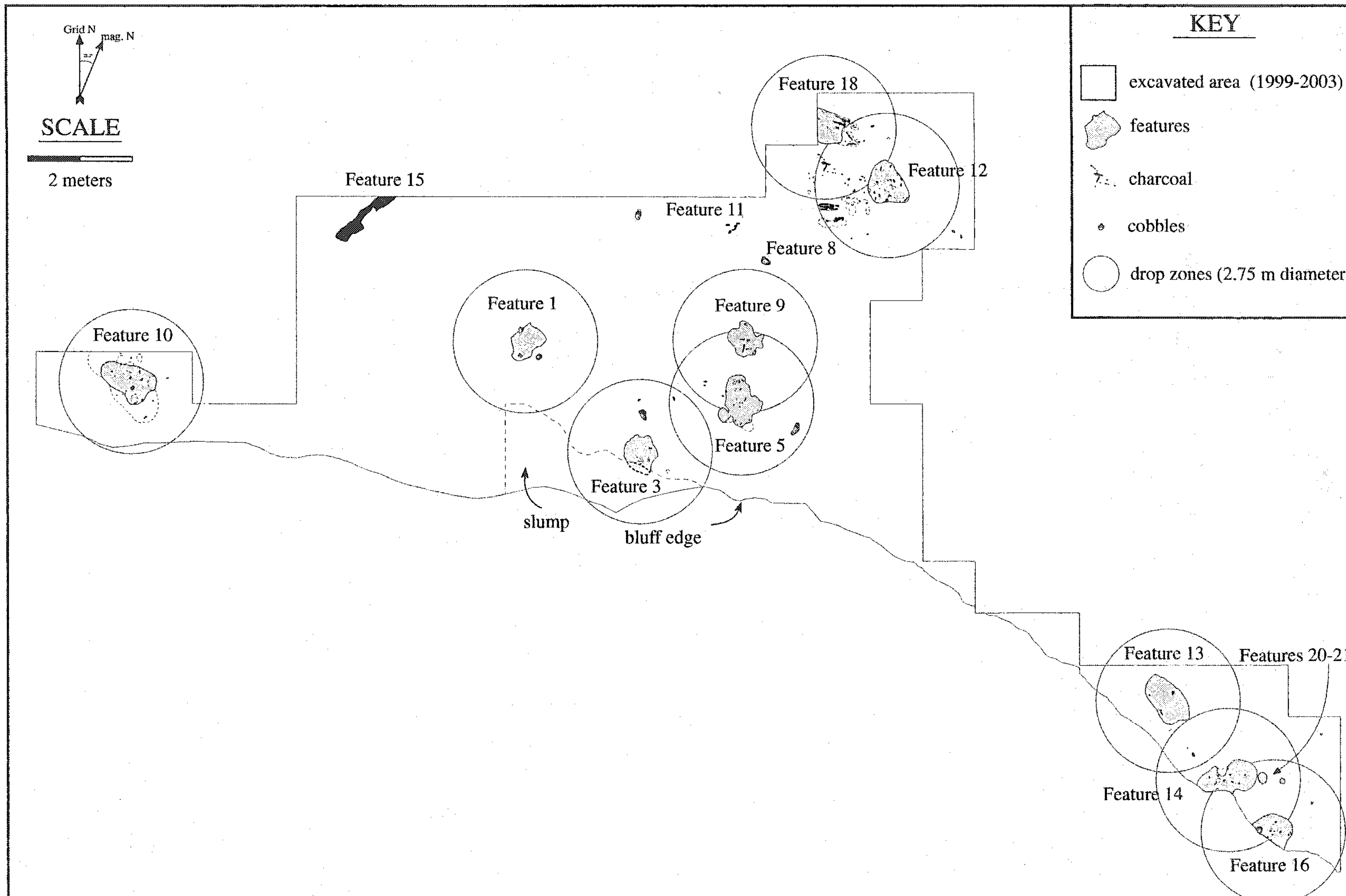


Figure 9.10 Component 3 feature distribution plan view.

Features 20 and 21 were two small circular reddish stains. They are much smaller than the hearths in plan view dimensions, and the lack of charcoal or burned bone or lithics suggests that they are not burn features. It is possible they are stains created by crushed and dispersed red ochre.

Feature 1 (hearth)

Feature 1 is a sub-circular hearth, defined by a discrete oxidized loess lens with charcoal fragments, burned bone, and possible hearthstones (Figures 9.11-9.13). Feature 1 is 70 cm across along its widest axis (southwest to northeast) and 45 cm wide across its shortest axis (southeast to northwest), with a surface area of about 0.99 m^2. Cross section is lenticular to plano-convex (see Figures 9.12-9.13). Cross sections indicate a maximum thickness of 5 cm, thinning toward the edges. Three schist fragments surround the hearth, one found below the vertebra fragments at the north end of the hearth, one at the southern end, and one about 10 cm southeast of the oxidized boundary to the south. The schist fragments measure from 85 to 185 mm at the maximum dimension, and weigh between 363 and 1497 g.

The boundary for this feature is quite clear, and no evidence of smearing is present. The oxidization is considered relatively strong and the outer edge is discrete. No other features were observed near it, and no large charcoal fragments were found outside of the Feature 1 oxidized area. Compared with the other hearths, this hearth is relatively charcoal poor. Four 3-pointed charcoal samples from within the feature were collected, one yielding a radiocarbon date of 8860±70 BP (β-133750). Due to the potential presence of large numbers of very tiny flakes, the oxidized matrix was catalogued by 29 10 x 10 cm units within EUN49E42, 2 other bags in EUN49E42, and 1 other bag in EUN48E42 (note, the other hearth matrices were generally bagged by 0.25m^2 quads. All sediment, charcoal, etc. within the oxidized lens was collected. In the laboratory, lithic items were removed from these matrix bags and catalogued separately. The size of charcoal fragments was generally small, about 5 cm in maximum dimension. The charcoal fragments were found throughout the hearth, from the top to the bottom.

Faunal remains associated with Feature 1 were collected in 14 provenience units, with a total of 54 bone fragments with a total weight of 350.7 g. The area used to quantify the associated faunal remains is 0.75 m^2 (3 quads). The faunal scatter was centered (by weight

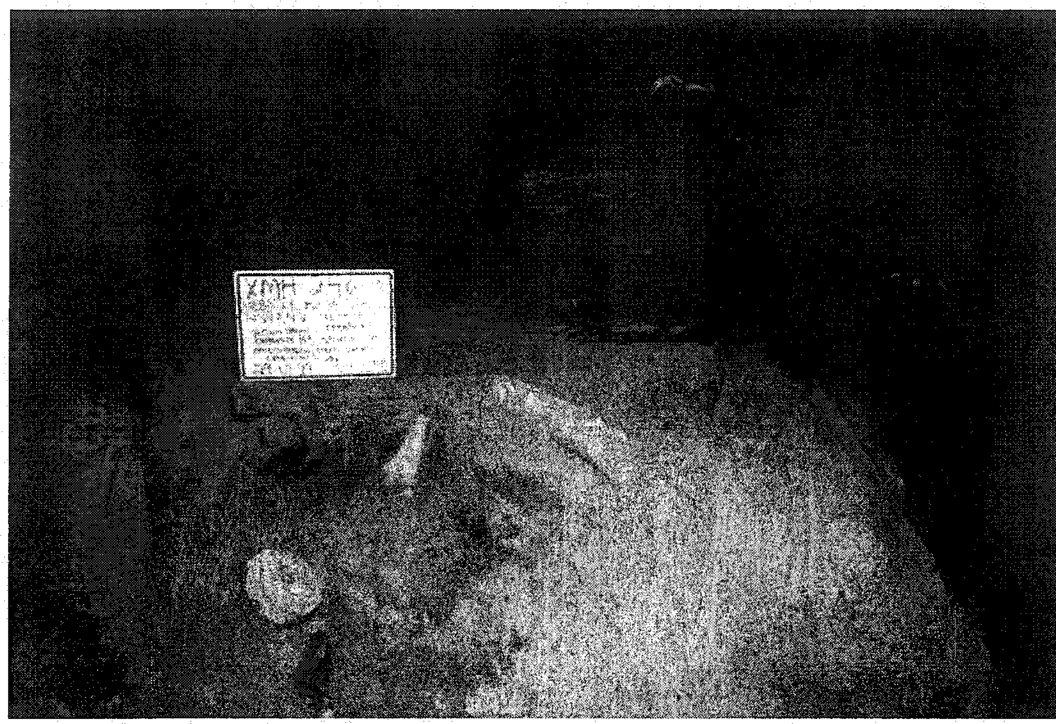


Figure 9.11 Feature 1 plan view, view grid west.

Figure 9.12 Feature 1 cross section, view west (note stratum R5 below hearth).

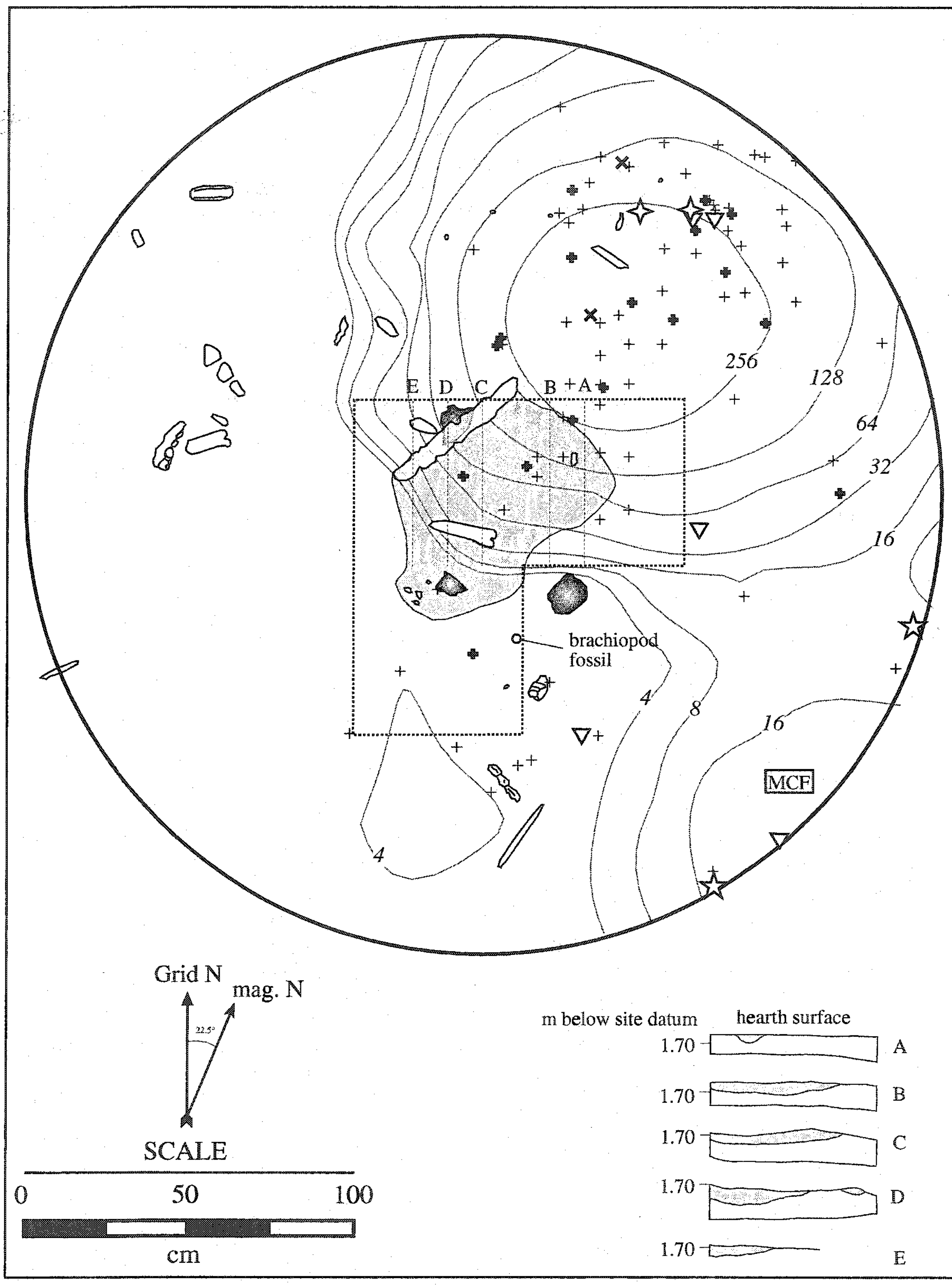


Figure 9.13 Feature 1 plan view and cross sections.

density isopleths, see Figure 6.12) directly on the hearth. Mean weight is higher than all other hearths (except Feature 16), largely due to the presence of an articulated vertebral column situated on the northern edge of Feature 1. Weight density is by far the highest among the hearths (468 g vs. 2-300 g). The maximum dimension observed was 19.9 cm, with mean and median maximum dimensions per lot of 3.4±5.2 cm and 1.3 cm respectively. A *Bison* R distal metacarpal (+90% of diaphysis), a probable *Bison* L (?) distal metacarpal, and unidentified large mammal vertebra were associated with Feature 1. Nine of the 14 provenience units were identified as medium to very large mammals, and four of those were identified as large to very large mammals. No small or medium-sized mammal bones were recorded. Faunal shape is heavily skewed by the vertebrae (61% irregular bone by weight), and there are relatively few unidentified (4%). 63% of the remains (by weight) are burned, typically black and brown charred.

Faunal cluster F3 was directly associated with Feature 1 (see Chapter 6). This cluster is interpreted as a marrow processing area, characterized by low average weights, low shaft weight (as percent of all long bones), relatively higher %long bone weights, and much higher %burn weights, and high degree of fragmenation (see Table 6.6). However some characteristics are different with respect to other processing areas in Component 3. Cluster F3 has more teeth fragments, higher %NISP weight, much higher %axial and %teeth weights, and absence of any upper limbs, (see Table 6.6). Much of these differences are due to the presence of the articulated vertebra column (UA99-62-288), interpreted to be five lumbar vertebrae. In addition to the identifiable specimens described above, a number of specimens were found within 75 cm of the hearth, including a *Cervus* R mandible with P4, M1, M2, M3, *Cervus* R mandibular M3, *Cervus* L maxilla with P4, M1, and M2, and a worked *Mammuthus* ivory tusk fragment. A brachiopod fossil was found about 15 cm south of the hearth. This identification was confirmed by Dr. Sarah Fowler, paleontologist at UAF.

Detailed spatial analyses are provided in Chapter 10. Lithic clusters were found to the northeast and southwest of Feature 1 (Subarea B1), but very few lithics were found within the hearth (Figure 9.13). The area to the west of the hearth was generally devoid of lithics. Lithic tools located within the drop zone include modified microblades, microblade core tablets, a microblade core fragment, modified flakes, and burin spalls.

Reuse potential for Feature 1 is considered relatively low given the discrete nature of the oxidized silt, the limited spatial clustering of lithic artifacts, bone fragments, and other cultural material. The feature does not exhibit smearing, and few large charcoal fragments were found nearby.

Feature 3 (hearth)

Feature 3 is a sub-circular hearth, defined by a discrete oxidized loess lens with numerous charcoal fragments and burned bone (Figures 9.14-9.16). Feature 3 is 65 cm across east-west and 65 cm across north-south, with a surface area of about 1.33 m^2. Since the hearth was discovered eroding out of the bluff face in 2000, it likely measured approximately 75 cm across north-south, with a surface area estimate of about 1.53 m^2. The slump that occurred in the spring of 2000 would have incorporated the entire hearth. All of the slumped material was screened, and given the absence of Component 2 in that area, it is almost certain that these materials relate to Component 3. The cross section is lenticular (see Figure 9.15), and indicate a maximum thickness of 6 cm, thinning toward the edges. No cobbles were directly associated with Feature 3, but a large cobble was located 30 cm to the north. A spall scraper was found about 7 cm northeast of Feature 3. Two clusters of calcined bone were noted within Feature 3, one near the bluff edge to the south (diameter of 10 cm), the other in the northeast area of the hearth (diameter of 7 cm).

The boundary for Feature 3 is quite clear, and no evidence of smearing is present. The oxidization is considered relatively strong and the outer edge is discrete. No other features were observed near it. The only charcoal found nearby was a small cluster of charcoal associated with two bone fragments about 28 cm east of Feature 3. Compared with the other Component 3 hearths, this hearth is relatively charcoal rich. Four 3-pointed charcoal samples were collected within the feature, and the oxidized matrix was catalogued in three bags. Charcoal from within one of the matrix bags yielded a date of 8950±40 BP (β-167395). All sediment, charcoal, etc. within the oxidized lens was collected. The size of the charcoal fragments was generally small, about 5 cm in maximum dimension. The charcoal fragments were found throughout the hearth.

The area used to quantify the associated faunal remains is 1.00 m^2 (4 quads). Faunal remains associated with Feature 3 were collected in 25 provenience units. A total of 220 bone fragments were collected, with a total weight of 67.3 g. A faunal scatter was directly centered on Feature 3 (Figures 9.16 and 6.12). Mean weight per fragment is relatively low compared to the

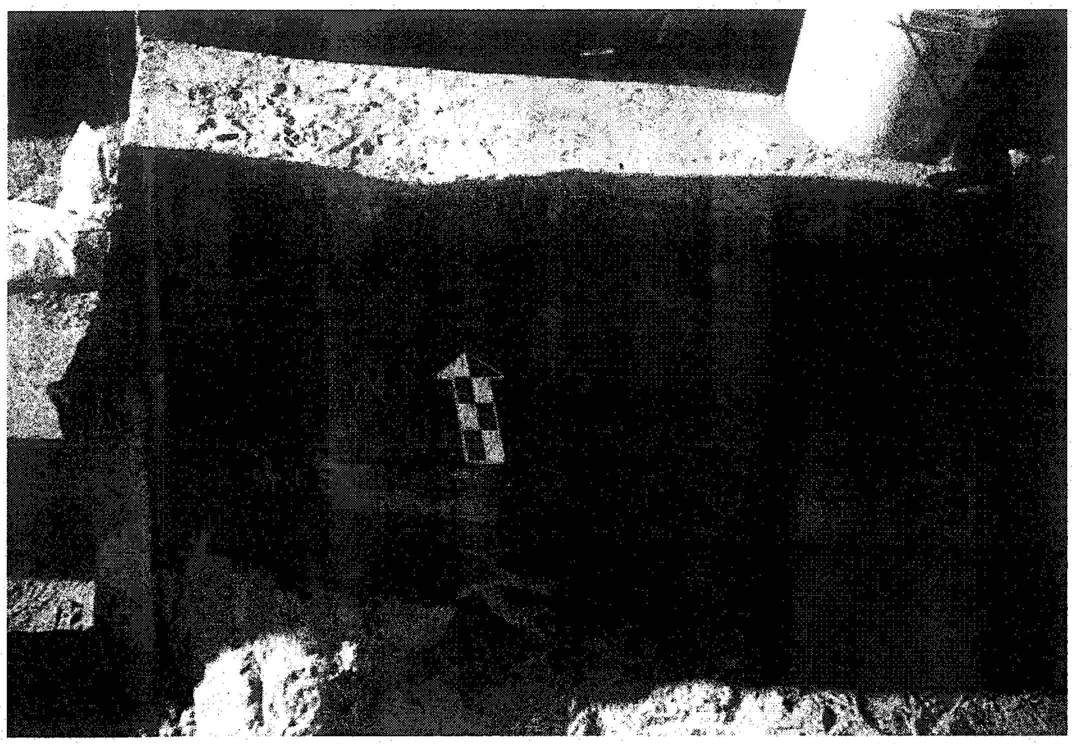


Figure 9.14 Feature 3 plan view, view grid north (note metacarpal on the left and spall scraper on the right).

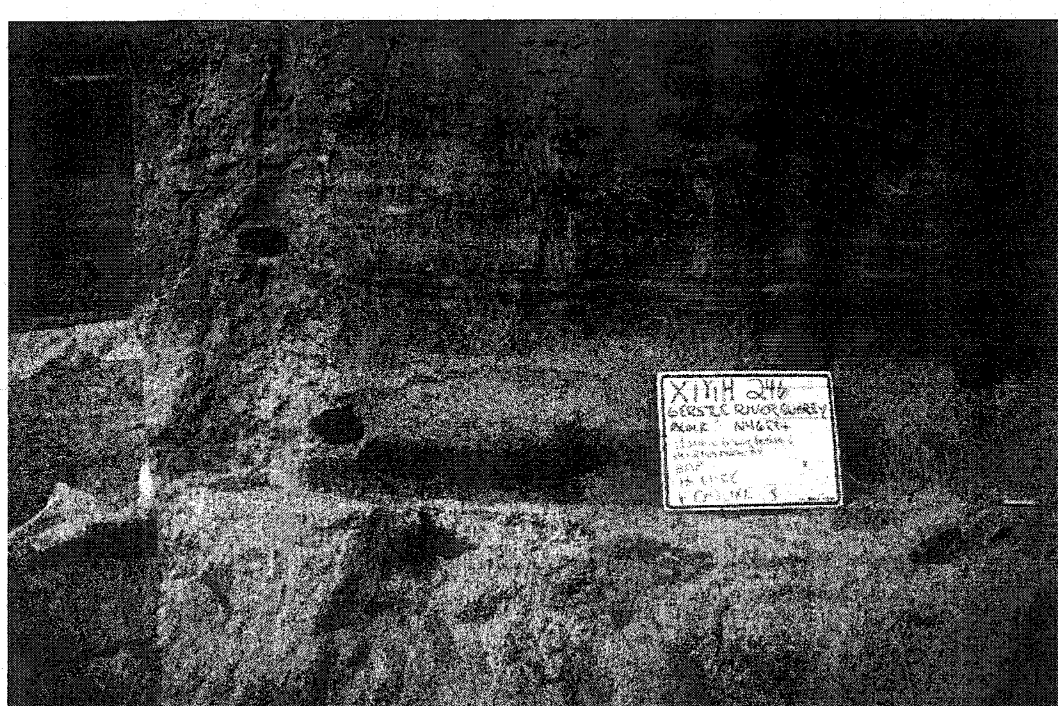


Figure 9.15 Feature 3 cross section, view grid north.

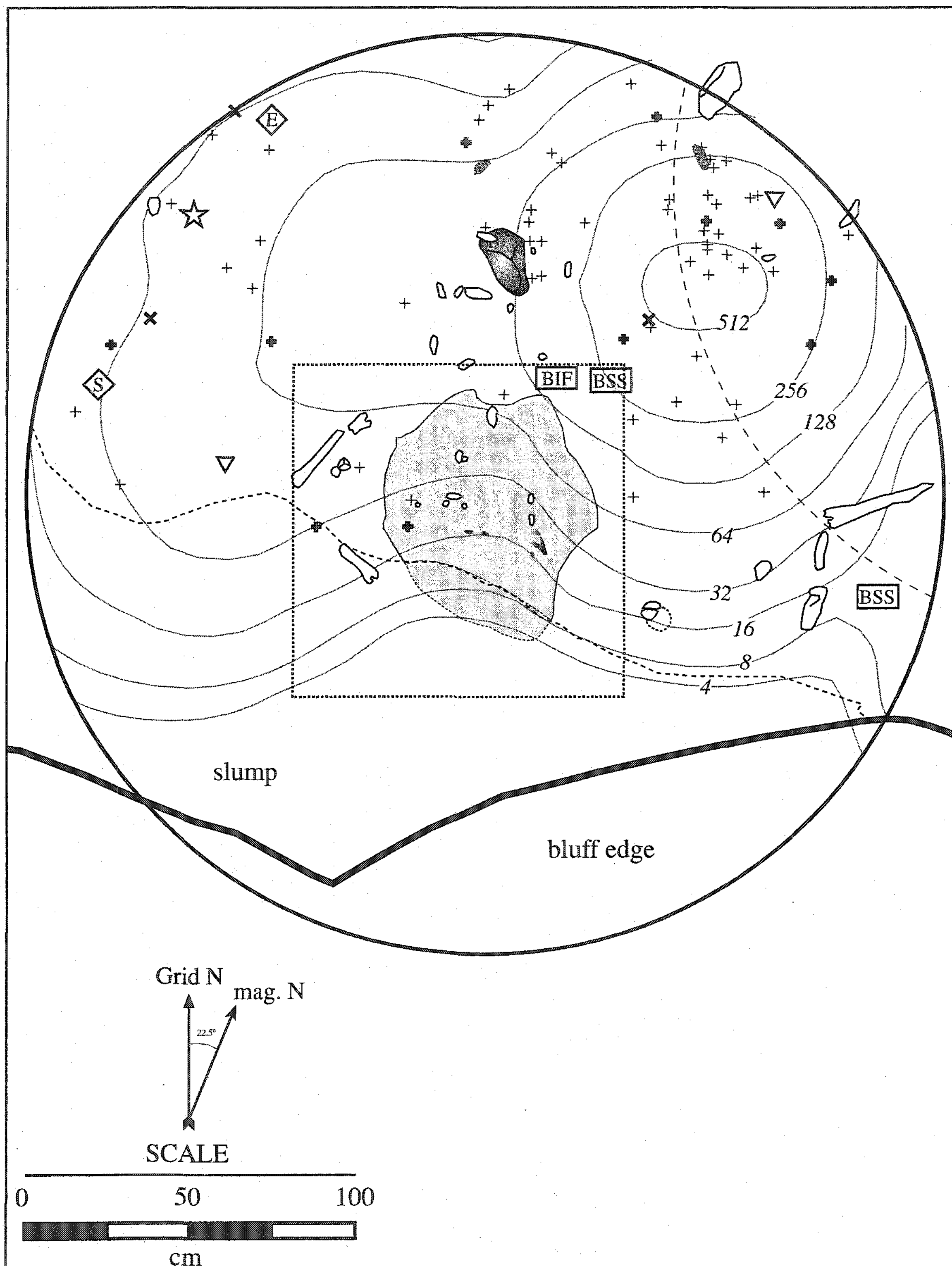


Figure 9.16 Feature 3 plan view.

other hearths. Weight density is relatively low, but fragment density is very high, indicating the presence of more numerous smaller fragments. The maximum dimension observed was 6.5 cm, with mean and median maximum dimensions per lot of 2.4±1.8 cm and 2.1 cm respectively. The only identified bone fragment includes a large mammal possible rib fragment. However, about 10 cm to the west of this hearth, identified bones include *Cervus* L 2nd and 3rd carpal, L metacarpal (in two fragments), L proximal metacarpal, and L unciform. No bison bones were identified within Feature 3. Twenty of the 25 provenience units were identified as medium to very large mammals, and five of those were identified as large to very large mammals. No small or medium sized mammal bones were recorded. Most of the remains are unidentified faunal shape (78%), more than any other (except Feature 9), and all of the remaining identifiable faunal shapes are long bone. A high percentage of faunal material was calcined (36% by weight), indicating immersion in the hearth at high temperatures or extended periods of time.

Faunal cluster F4 was directly associated with Feature 3 (and Feature 5) (see Chapter 6, Figure 6.12). This cluster is interpreted as a marrow processing area, characterized by low average weight, low shaft weight (as percent of all long bones), relatively higher %long bone weights, higher %burn weights, skeletal unit types of primarily lower limb bones, and high degree of fragmenation (see Table 6.6). In addition to the identifiable specimens described above, a number of specimens were found within the drop zone, including *Bison* L calcaneus, *Cervus* L distal metatarsal, R distal metatarsal, L proximal radius, R maxilla including P3, P4, M1, and M2, and large artiodactyl L femur lateral condyle fragment, and possible rib fragment.

Detailed spatial analyses are provided in Chapter 10. Two lithic clusters were found, a dense cluster of microblades and flakes to the northeast and a smaller concentration of tools, microblades, and flakes to the northwest (Subarea B2), but relatively few lithics were found directly within the hearth (Figure 9.16). The northeast may relate to Feature 3 or Feature 5, however, the northwest cluster almost certainly is associated with Feature 3 given the intervening distance to Feature 1. While the slumped area was situated just south of Feature 3, all the material was screened, and this yielded only 34 flakes, 7 microblade fragments, and 1 microblade core tablet. Lithic tools located within the drop zone include modified microblades, microblade core tablets, modified flakes, spall scrapers, bevelled flakes (short axis and long axis retouched), and a biface fragment. A large cobble of angular granite is located about 25 cm north of Feature 3 and may have functioned as an anvil stone. Numerous bone fragments were recovered around this cobble.

Reuse potential for Feature 3 is considered relatively low given the discrete nature of the oxidized silt, the limited spatial clustering of lithic artifacts, bone fragments, and other cultural material. The feature does not exhibit smearing, and few large charcoal fragments were found nearby.

Feature 5 (hearth)

Feature 5 is a hearth, defined by an oxidized loess less with numerous charcoal fragments and burned bone (Figures 9.17-9.19). A localized area of charcoal concentration and some weak oxidization, less pronounced than Feature 3, was observed in 2000 and designated Feature 4. Another oxidized area directly east of this was designated Feature 5. As the excavation proceeded, it was determined that these represented the same hearth feature, where the eastern lobe was located slightly higher than the western lobe, but the connection was observed during excavation. Therefore, Feature 4 is subsumed under Feature 5. Feature 5 is 80 cm across east-west and 100 cm across north-south, with a surface area of about 2.51 m^2. The cross section is lenticular (see Figures 9.18-9.19), and indicate a maximum thickness of about 6 cm, thinning toward the edges. No cobbles were directly associated with Feature 5.

The boundary for this feature is somewhat diffuse, and less sharp than for Features 1 and 3; however the boundary does not appear smeared, and charcoal fragments are not found outside the oxidized area. The boundaries representing more indistinct or fainter staining are represented with dotted lines (Figure 9.19). The portion of Feature 5 excavated in 2001 appeared stronger and more distinct. The moisture content in the air and sun angle may have an effect on clarity of the boundaries of the oxidized sediment. Feature 9 is located about 32 cm from Feature 5 at their closest edges, though the centroids are about 125 cm apart. Compared with the other hearths, this hearth is relatively charcoal rich. Fourteen 3-pointed charcoal samples from within the feature were collected, one yielding a radiocarbon date of 8890±40 BP (β-167397). The oxidized matrix was collected and catalogued in three bags. All sediment, charcoal, etc. within the oxidized lens was collected. The size of the charcoal fragments ranged from 2 to 7 cm in maximum dimension. The charcoal fragments were found throughout the hearth. Faunal remains were situated primarily to the southwest and western portions of Feature 5, but were found throughout the feature.

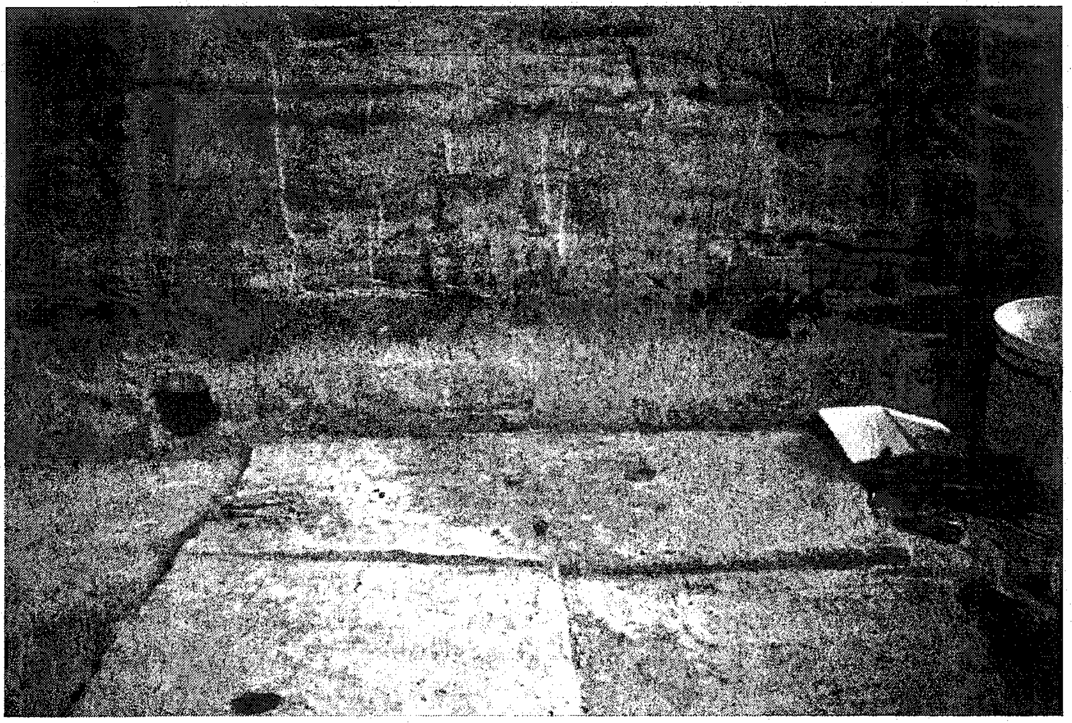


Figure 9.17 Feature 5 plan view (2000 excavation), view grid north (note Feature 4 bone and staining at center-left).

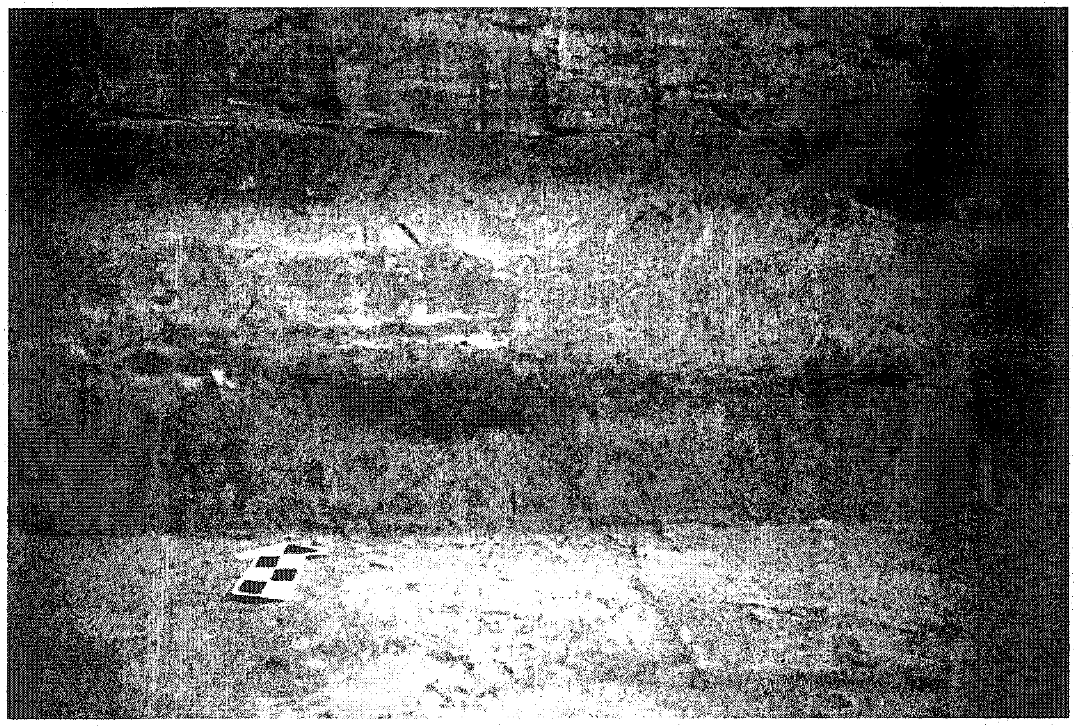


Figure 9.18 Feature 5 cross section, view grid north.

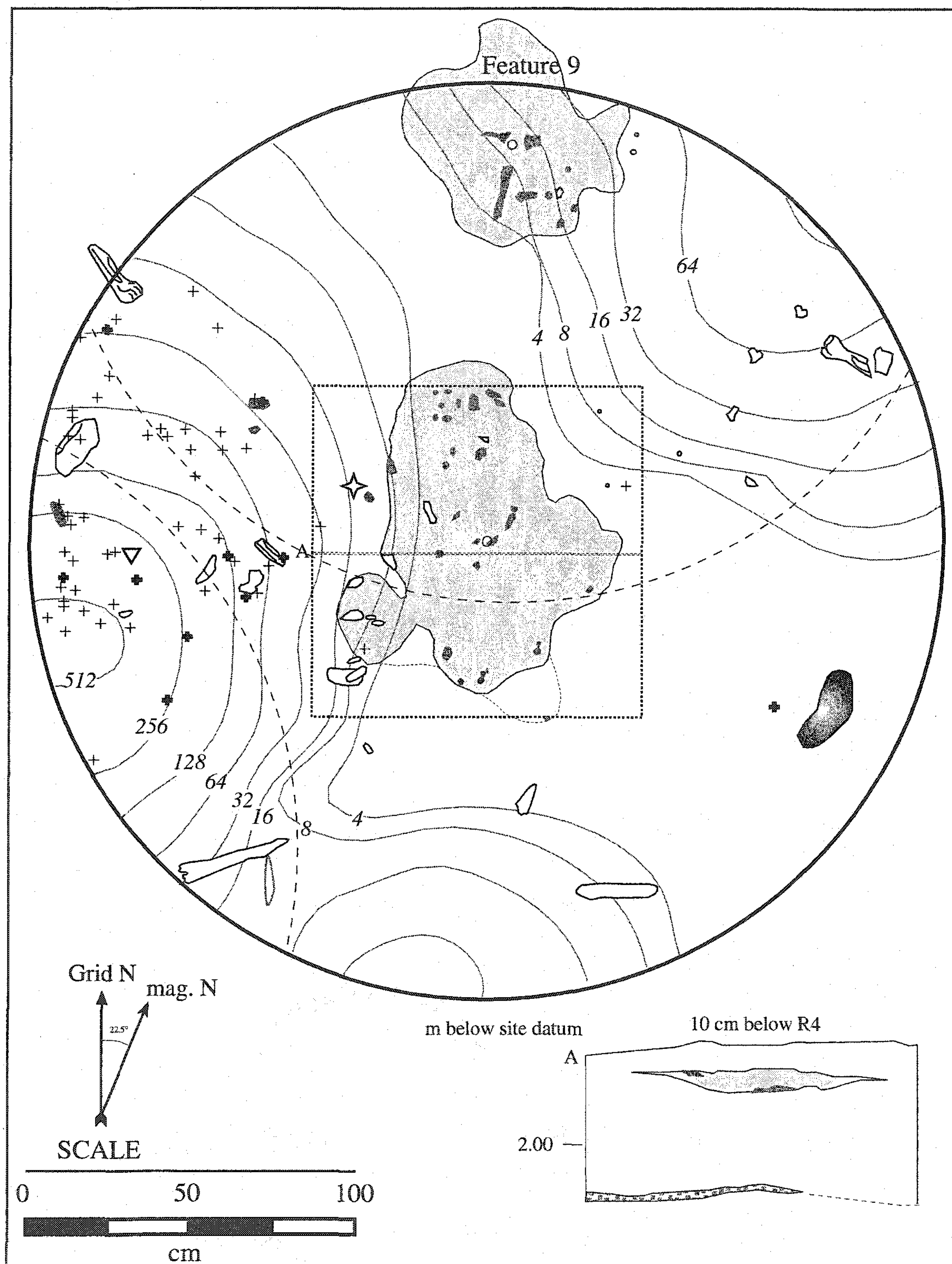


Figure 9.19 Feature 5 plan view and cross section.

The area used to quantify the associated faunal remains is 1.00 m^2 (4 quads). Faunal remains associated with Feature 5 were collected in 19 provenience units. A total of 150 bone fragments were collected, with a total weight of 105.3 g. The faunal scatter is situated primarily to the west of Feature 5, though a number of remains were found at the western part of Feature 5 (earlier denoted as Feature 4) (see Figure 9.14). Mean weight per fragment is consistent with the other hearths. Weight density is near the average of all Component 3 hearths (105 vs. average of 138 g/m^2), but fragment density is relatively high (150 vs. average of 77). While this pattern is not as extreme as that observed for Feature 3 faunal remains, it does suggest similar processes may have occurred (i.e., resulting in numerous small fragments). The maximum dimension observed was 8.9 cm, with mean and median maximum dimensions per lot of 2.7±2.2 cm and 2.6 cm respectively. No identifiable specimens were found directly associated with Feature 5.

Thirteen of the 19 provenience units were identified as medium to very large mammals. No small or medium sized mammal bones were recorded. Faunal shape by weight includes unidentified fragments and long bone fragments only. 33% of the remains (by weight) are burned, typically calcined and black charred.

Faunal cluster F4 was directly associated with Feature 5 (and Feature 3) (see Chapter 6, Figure 6.12). This cluster is interpreted as a marrow processing area, characterized by low average weight, low shaft weight (as percent of all long bones), relatively higher %long bone weights, higher %burn weights, skeletal unit types of primarily lower limb bones, and high degree of fragmenation (see Table 6.6). In addition to the identifiable specimens described above, a number of specimens were found within the drop zone, including a *Cervus* R distal metatarsal, L distal humerus, L distal tibia, L astralagus, and R. maxilla including P3, P4, M1, and M2.

Detailed spatial analyses are provided in Chapter 10. Two lithic clusters were found, a dense cluster of microblades and flakes to the west (Subarea B2) and a smaller concentration of flakes to the northeast (Subarea B3), but few lithics were found directly within the hearth (Figure 9.19). The western cluster may relate to Feature 5 or Feature 3 and the northeastern cluster lies closer to Feature 9. Lithic tools located within the drop zone include modified microblades and a microblade core facet rejuvenation flake. A large cobble was found 75 cm to the southeast of Feature 5, but no associated fauna and few lithics were found other than a modified microblade.

Reuse potential for Feature 5 is considered moderate to low. The boundary of the oxidized silt is relatively discrete, no large charcoal fragments were found nearby, and the spatial clustering of lithic artifacts is limited; however, the boundary of the oxidized silt is somewhat diffuse.

Flotation of all Feature 5 sediments yielded a 6.3 g light fraction including 12 *Vaccinium vitis-idaea* seeds, an insect part, and numerous charcoal fragments and a 7.8 g heavy fraction including 4 bone fragments, 1 calcined, 1 black charred, 2 brown-charred, for a total weight of 1.6 g and 8 subangular to subrounded pebbles of various lithologies about the same size (around 1 cm diameter), weighing 1.8 g (Gelvin-Reymiller 2004).

Feature 8 (charcoal scatter)

Feature 8 is a scatter of charcoal fragments and small patches of gray-colored organic rich silt spatially associated with Component 3 lithics and bone fragments (Figures 9.20-9.21). In the northeast corner of the excavation (Block T), patches of organic rich silt, large charcoal fragments, associated lithics, and bone fragments were discovered in 2001. No oxidized sediments were found in that area. The lithics, fauna, and charcoal associated with this feature were in direct association, and one charcoal sample was submitted for dating, yielding a radiocarbon date of 9130±40 BP (β-167398). Further excavation in 2002 and 2003 revealed two distinct hearth features east and north of Feature 8. The nearest, Feature 12, was approximately 10 cm northeast of the nearest gray patch of Feature 8 (Figure 9.21).

Additional charcoal fragments were revealed scattered to the north of Feature 8 and west of Feature 12. The overall shape of this charcoal scatter is like a horseshoe, with the bottom of the "U" directly adjacent to Feature 12. The space within the "U" is between 35 and 60 cm of loess devoid of charcoal fragments. The total size of Feature 8, based on the distribution of charcoal fragments (not just the gray organic rich silt patches), is 125 cm north to south and 115 cm east-west, with a surface area of 6.32 m^2. However, most of this area consists of the "space" between the two arms of the "U." A total of 18 separate charcoal samples were taken. The gray organic rich silt patches were relatively thin, generally less than a few cm thick.

While some bone was associated with Feature 8, most of the bone scatter extends to the south, and there is no spatially limited bone concentrations directly associated with Feature 8 (see Features 1 and 3 for examples of bone concentrations directly associated with features).

The area used to quantify the associated faunal remains is 2.00 m^2 (8 quads). Faunal remains associated with Feature 8 were collected in 31 provenience units. A total of 54 bone fragments were collected, with a total weight of 215.6 g. Mean weight per fragment is near to the average for all Component 3 features and weight density is average, but fragment density is low, suggesting a small number of large fragments. The maximum dimension observed was 16.2 cm, with mean and median maximum dimensions per lot of 4.0±4.1 cm and 2.8 cm respectively. No identifiable specimens were found directly associated with Feature 8 except for one possible large mammal vertebral fragment. Twelve of the 31 provenience units were identified as large to very large mammals. No small or medium sized mammal bones were recorded.

Faunal cluster F6b was spatially associated with Feature 8, though it was also associated with Hearth Features 12 and 18 (see Chapter 6, Figure 6.12-6.13). This cluster is interpreted as a processing area, characterized by low average weights, high %long bone weights, high %burn weights, high %appendicular specimens, and high degree of fragmenation. However, this cluster is the most dissimilar from other processing areas in terms of high %shaft weight and high %upper limb bones.

Detailed spatial analyses are provided in Chapter 10. Lithic clusters were found centered on Feature 8 (Subarea C2) and to the northeast (Subarea C3). The presence of numerous lithics directly within Feature 8 is a dissimilarity with the hearth features, where lithics tend to be concentrated at one or more sides of the feature. Lithic tools located within the drop zone include modified microblades, microblade core tablets, modified flakes, spall scrapers, and burin spalls.

Reuse potential for Feature 8 is considered low, but potential for disturbance after primary deposition is considered moderate to high. There is no associated oxidized sediment, and the presence of charcoal over a relatively wide area suggests some post-depositional disturbance, likely anthropogenic given the stratigraphy and living floor integrity. The presence of numerous lithic artifacts and bone in this area further increases the probability for reuse.

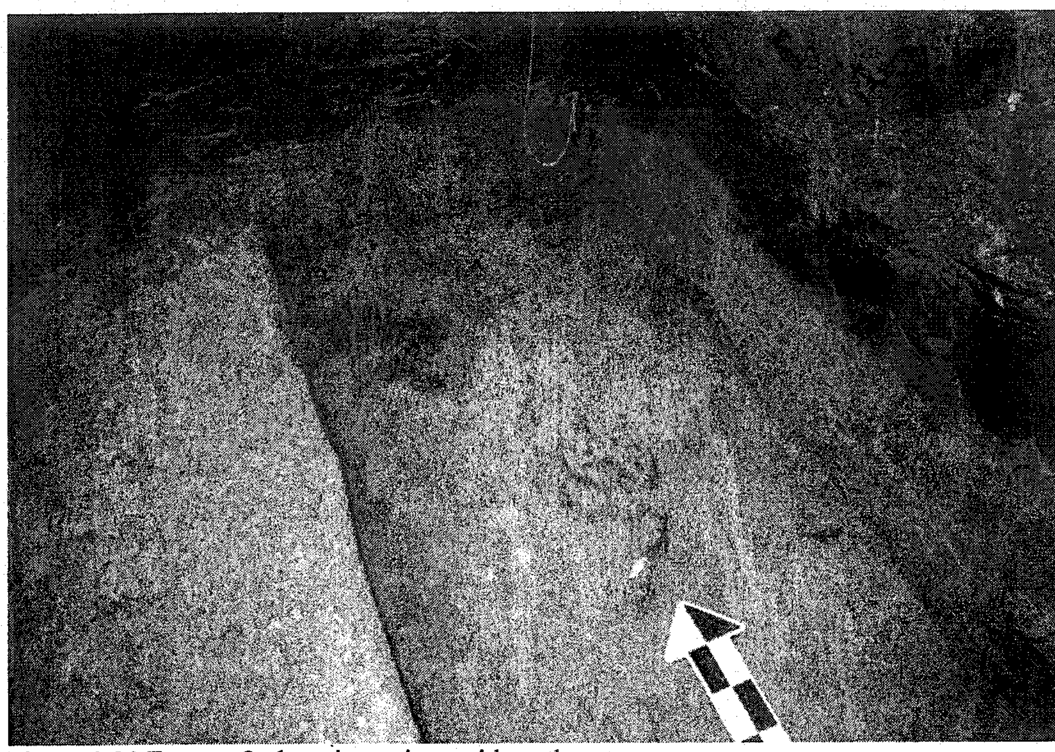


Figure 9.20 Feature 8 plan view, view grid northeast.

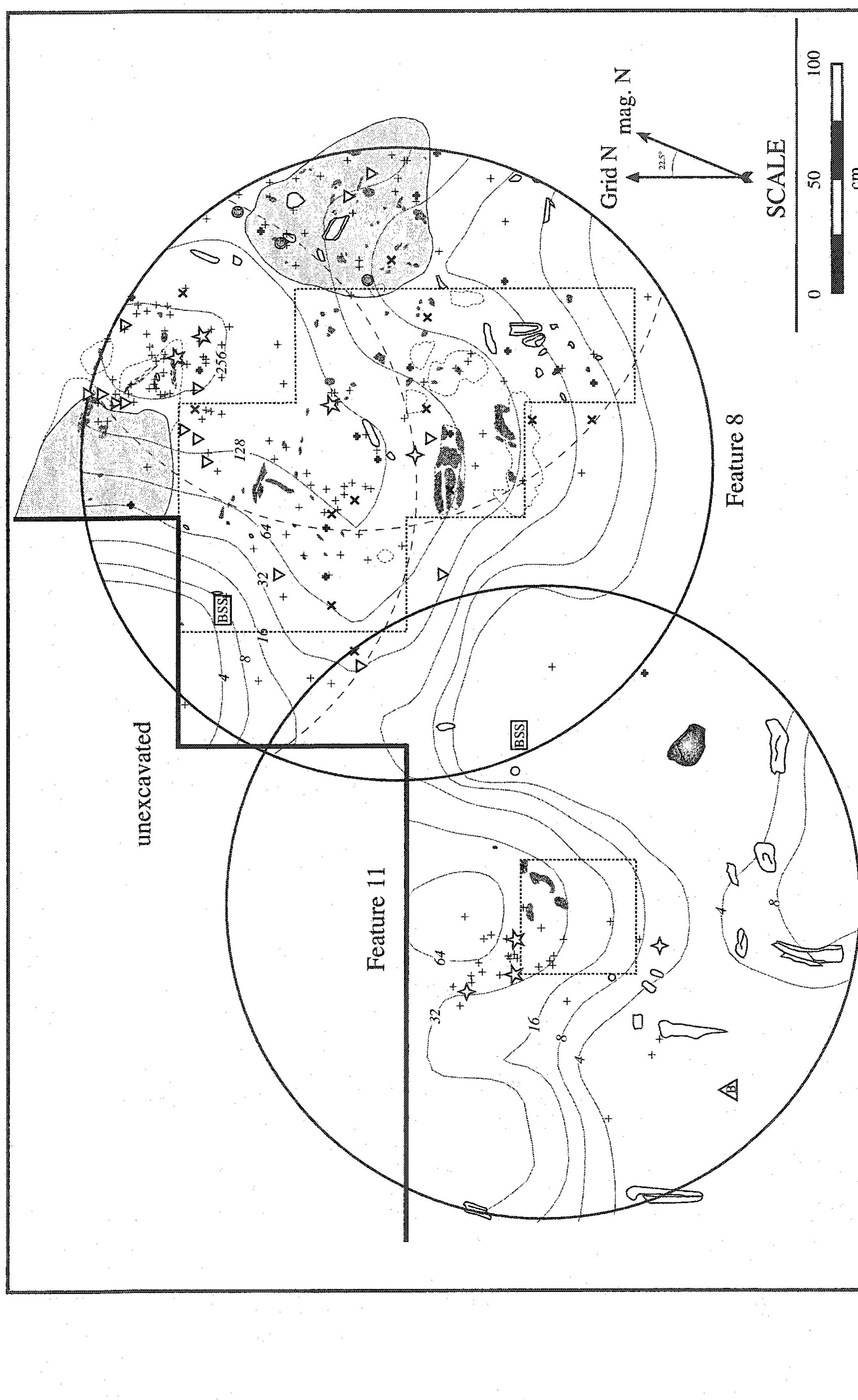


Figure 9.21 Feature 8 and 11 plan views.

Feature 9 (hearth)

Feature 9 is a sub-circular hearth, defined by a discrete oxidized loess lens with numerous charcoal fragments and burned bone (Figures 9.22-9.24). Feature 9 is 65 cm across east-west and 65 cm across north-south, with a surface area of about 1.33 m^2. The cross section is lenticular (see Figure 9.23), indicating a maximum thickness of 5 cm, thinning toward the edges. No cobbles were found in direct association. Charcoal was found throughout the oxidized sediment.

The boundary for this feature is clear, and no evidence of smearing is present. The oxidization is considered relatively strong and the outer edge is discrete. Feature 5 is located about 32 cm from the southern oxidized border of Feature 9, though the centroids are about 125 cm apart. These are the closest hearths at the site. No large charcoal fragments were found between these two hearths. Compared with the other hearths, this hearth is relatively charcoal rich. Two 3-pointed charcoal samples from within this feature were collected, one yielding a radiocarbon date of 9030±70 BP (AA-51254). The oxidized feature matrix was catalogued in one bag. The size of charcoal fragments varied from small to relatively large (2 cm to a piece 15 cm long).

The area used to quantify the associated faunal remains is 0.75 m^2 (3 quads). Faunal remains associated with Feature 9 were collected in one provenience unit, with a total of 2 unidentified mammal fragments weighing 1.8 g. The maximum dimension observed was 3.1 cm. No identifiable specimens were found directly associated with Feature 9. No faunal clusters were directly associated with Feature 9 aside from the two bone fragments described above, though a large faunal cluster was present north and northwest of the feature (faunal cluster F5).

Detailed spatial analyses are provided in Chapter 10. A single lithic cluster was found to the east o Feature 9 (Subarea B3), but relatively few lithics were found within the hearth (Figure 9.24). No lithic tools were found within the drop zone except for a spall scraper associated with the bones to the northeast.

Reuse potential for Feature 9 is considered relatively low given the discrete nature of the oxidized silt, the limited spatial clustering of lithic artifacts, bone fragments, and other cultural material. The feature does not exhibit smearing, and few large charcoal fragments were found nearby.

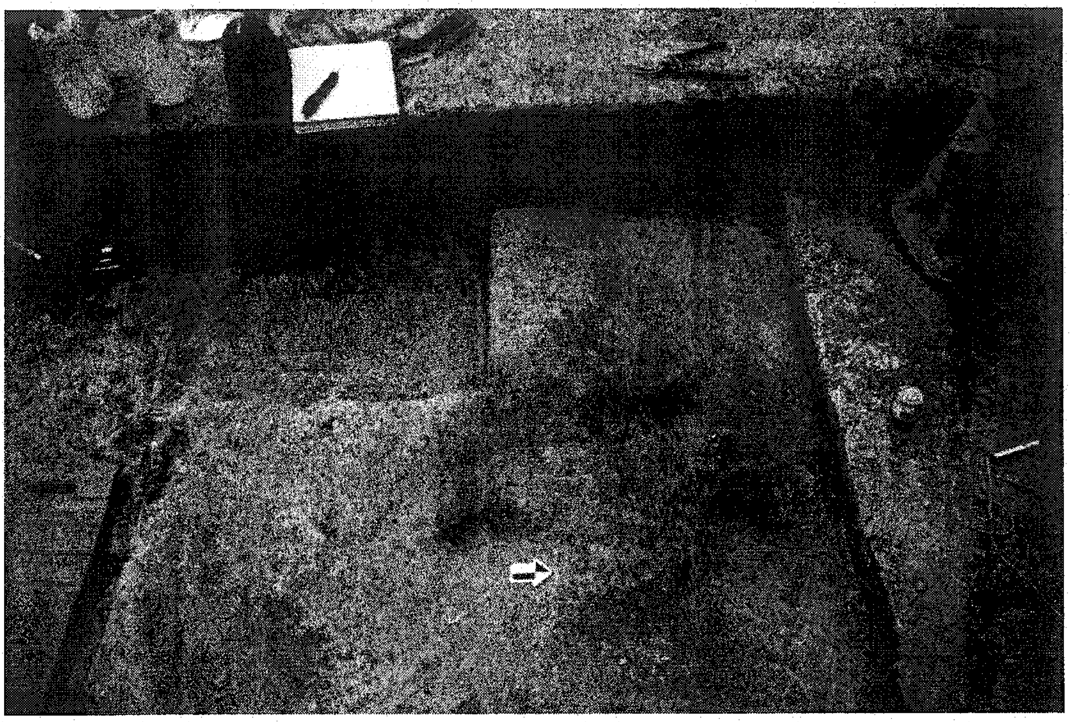


Figure 9.22 Feature 9 plan view, view grid west.

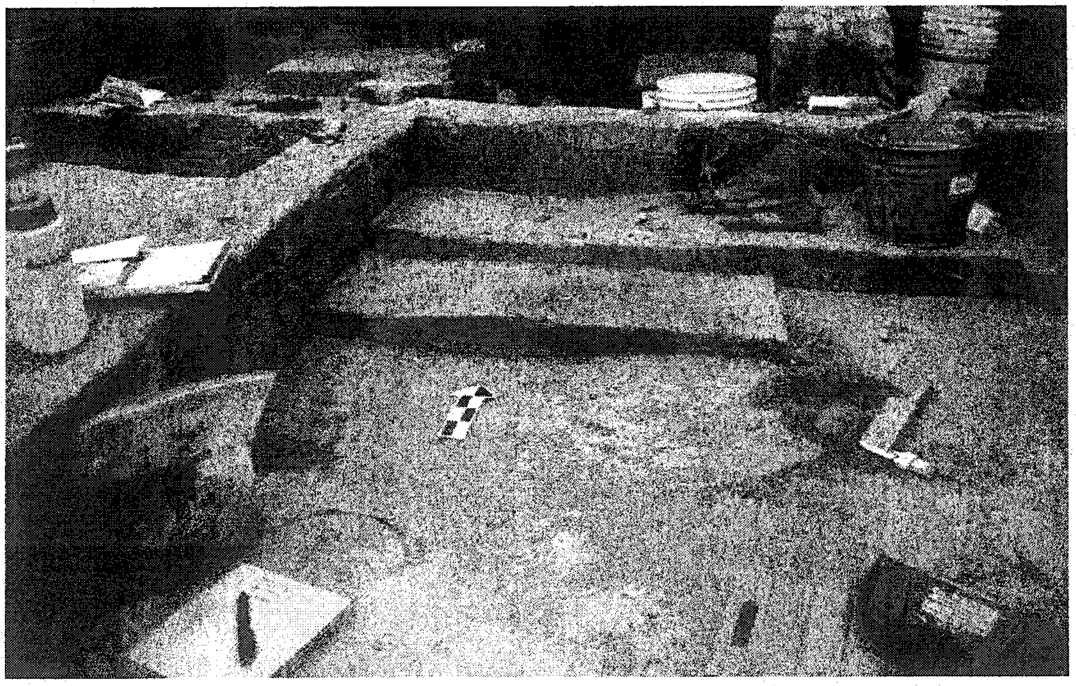


Figure 9.23 Feature 9 cross section, view grid north (note matrix bag for Feature 9 at left).

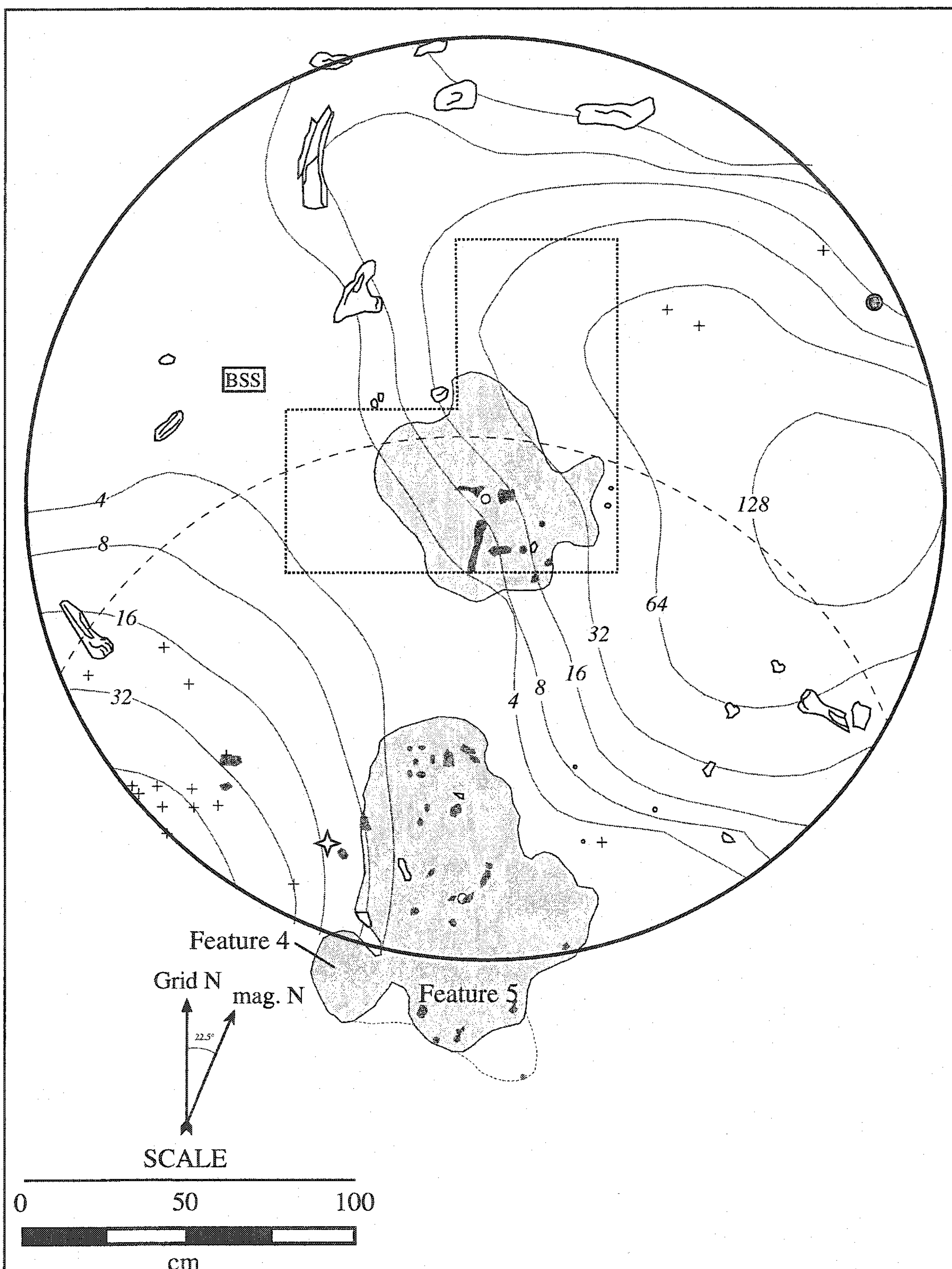


Figure 9.24 Feature 9 plan view.

Feature 10 (hearth)

Feature 10 is a sub-circular hearth, defined by a discrete oxidized loess lens with charcoal fragments and burned bone (Figures 9.25-9.27). Feature 10 oxidized sediment is 110 cm across its longest axis (northwest to southeast) and 65 cm across its shortest axis (northeast to southwest). Cross section is lenticular, and indicates a maximum thickness of about 5 cm, thinning towards the edges (Figure 9.26). No cobbles were found associated with this feature.

The boundary for this feature is somewhat diffuse, and the presence of charcoal fragments and gray-stained (though not fully oxidized) loess suggests smearing may have occurred during or after creation and use. The dimensions of Feature 10 combining the oxidized sediment and the stained charcoal-rich sediment are 175 cm southeast to northwest and 80 cm southwest to northeast. Compared with the other hearths, this hearth is relatively charcoal rich. Fifteen 3-pointed charcoal samples directly associated with Feature 10 were collected, and the matrix was catalogued in one bag. Charcoal fragments were found throughout the oxidized area and within the gray stained loess, and one sample from the gray stained loess (collected in 2001) yielded a date of 8910±40 BP (β-167399). All of the oxidized sediment and constituent charcoal and bones were collected from Feature 10. The size of the charcoal fragments varied from <2 cm to 10 cm at their maximum dimension. Bone fragments were found throughout the hearth area, but were concentrated in the center and eastern portions of the hearth. The fragments from the center area were generally less charred, whereas those from the eastern area were more charred. The area of the burned bone concentration at the eastern portion measured 30 cm north to south and 17 cm east to west.

The area used to quantify the associated faunal remains is 1.75 m^2 (7 quads). Faunal remains associated with Feature 10 were collected in 31 provenience units. A total of 244 bone fragments were collected, with a total weight of 241.2 g. Mean weight per fragment and weight density is near the average for the all hearths. The maximum dimension was 13.2 cm, with mean and medium maximum dimensions per lot of 4.0±3.1 cm and 3.1 cm respectively. No identifiable bone fragments were observed within Feature 10. Fifteen of the 31 provenience units were identified as large to very large mammals. No small or medium sized mammal bones were recorded. Faunal shape consists of mainly unidentified fragments and long bone fragments. 33% of the faunal remains (by weight) were burned, typically black charred or calcined.

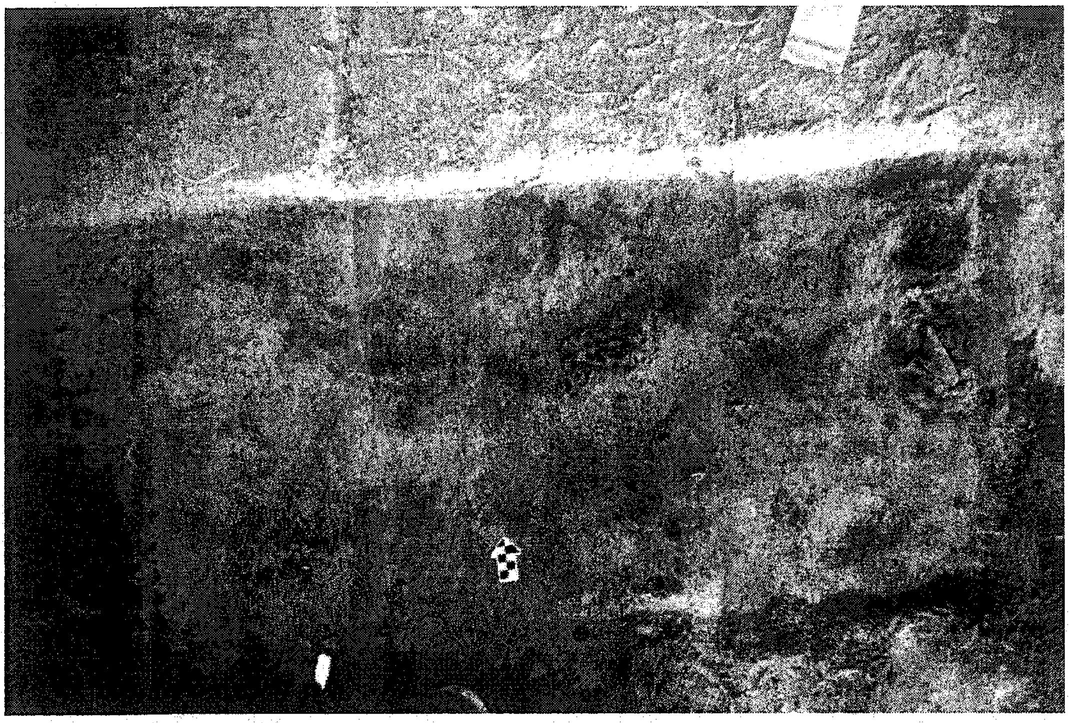


Figure 9.25 Feature 10 plan view (2002 excavation), grid south at top of image.

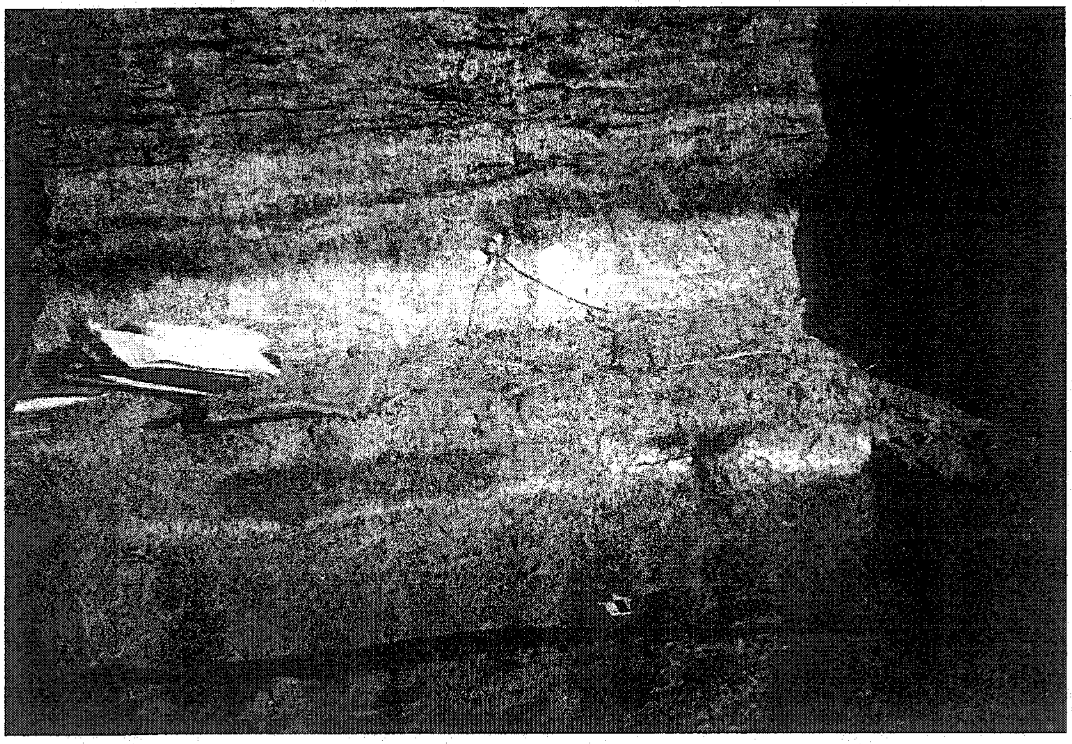


Figure 9.26 Feature 10 cross section, view grid north.

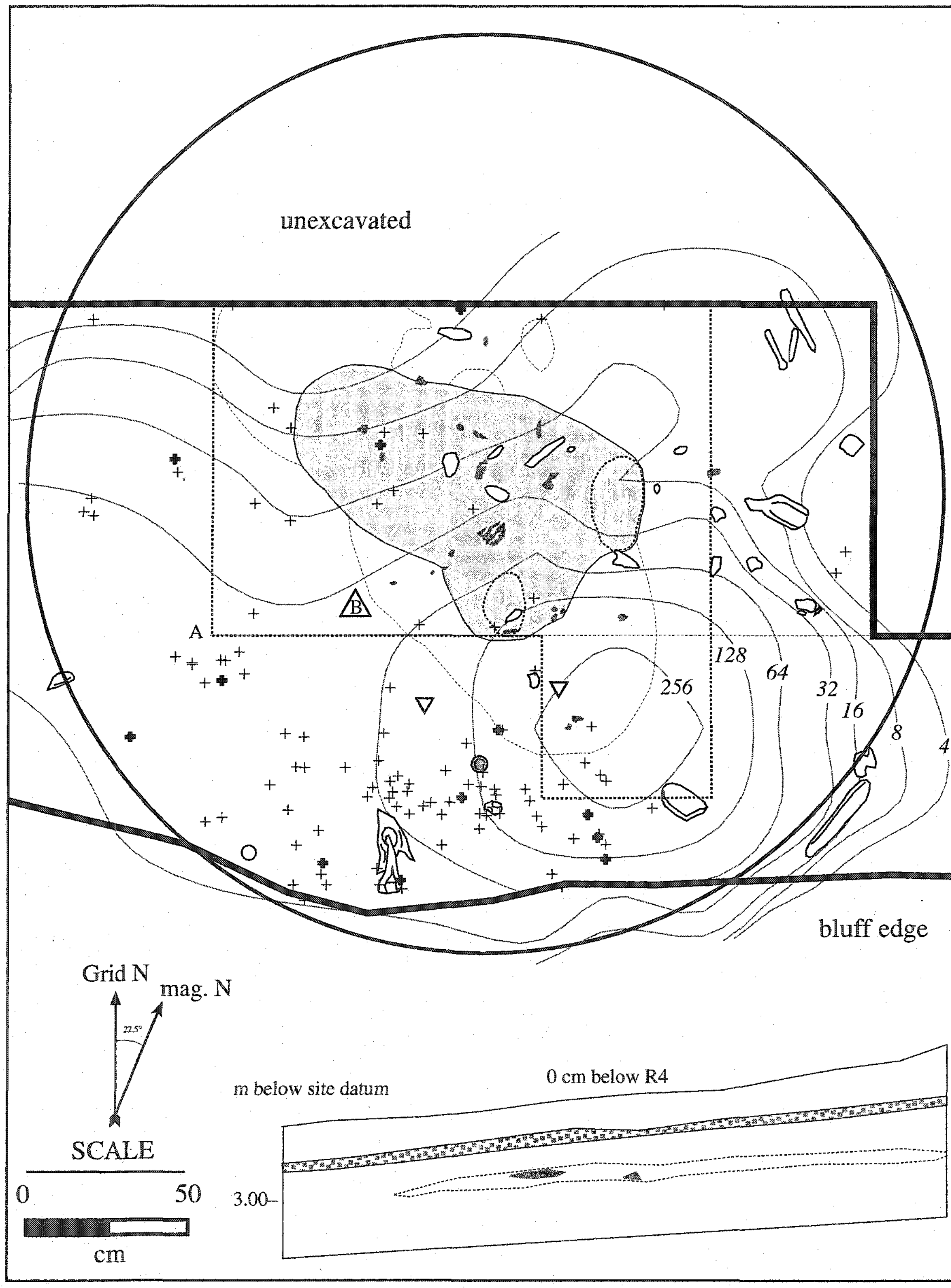


Figure 9.27 Feature 10 plan view and cross section.

Faunal cluster F1 was directly associated with Feature 10 (see Chapter 6, Figures 6.12-6.13). This cluster is interpreted as a marrow processing area, characterized by low %shaft weight, relatively higher %long bone weight, and higher %burn weights (see Table 6.6). Some characteristics are different with respect to other processing areas in Component 3. Cluster F1 has higher average weight/fragment, much higher weight density, relatively high %axial bone weight (21%), and low degree of fragmentation. However, these data are likely skewed by the presence of a number of larger specimens to the south of Feature 10. A number of specimens were found within the Feature 10 drop zone, including a *Bison* R 2nd and 3rd carpal, R radial carpal, R distal humerus, L innominate (acetabulum) fragment, R distal metacarpal, large artiodactyl metapodial condyle, rib fragment, and enamel fragment. Other fauna are found outside of the drop zone but within cluster F1, including *Cervus* L metatarsal, L and R mandibles, R 1st phalanx, L 1st phalanx, L complete metatarsal, and large artiodactyl L innominate (acetabulum fragment), molar or premolar fragments, and incisor. A spatial demarcation between bison and wapiti bones is apparent about 1.3 m west of Feature 10.

Detailed spatial analyses are provided in Chapter 10. Lithic clusters were found 50 cm to the southeast of Feature 10 (Area 1) composed of primarily flakes, and 75 cm to the southwest composed of primarily microblades. Though the area to the north of Feature 10 remains unexcavated, the lithic concentrations were clearly showing a decrease in density within Feature 10 and to the north (see Figure 9.27). Lithic tools located within the drop zone include modified microblades, a burin, and modified flakes.

Reuse potential for Feature 10 is considered moderate to low, but the potential for post-depositional disturbance is moderate. While the boundary of the oxidized silt is relatively discrete, there were contiguous areas of gray organic-rich sediment. This may have been the result of scattering the ashes of the fire after use, post-occupationally, or post-depositionally. The relatively small excavated area renders further interpretation difficult.

Flotation of all Feature 10 sediments yielded a 25.8 g light fraction including 4 *Vaccinium vitis-idaea* seeds, 3 *Betula* sp. fruits, 1 *Rubus idaeus* seed, 1 possible graminoid seed, 3 bud tips, numerous charcoal fragments, and an insect part and a 6.7 g heavy fraction including 46 bone fragments, 43 calcined, 3 black charred, for a total weight of 3.7 g and one angular pebble, 0.5 cm diameter (Gelvin-Reymiller 2004).

Feature 11 (charcoal scatter)

Feature 11 is a small, localized scatter of charcoal fragments associated with Component 3 lithics (Figure 9.28). A discrete cluster of lithics (Subarea B4) were in direct spatial association with this feature. No other charcoal fragments were observed near Feature 11; the nearest charcoal fragments were almost two meters away in Feature 8. The charcoal scatter measured 25 cm east-west and 20 cm north-south, with a surface area of about 0.16 m^2. The individual charcoal clusters are up to 15 cm in maximum extent, though they fragmented further upon recovery. Three separate charcoal samples from this feature were collected, one yielding a radiocarbon date of 9130±70 BP (AA-51253) (see Chapter 5). No faunal remains are associated with or within 50 cm of Feature 11.

Given that unexcavated area lies about 50 cm to the north, it is possible that this charcoal scatter may be related to an unexcavated feature to the north. The distance of these fragments from any other feature renders further interpretation difficult.

A lithic concentration was found directly associated with this charcoal scatter (Subarea B3). Two smaller clusters can be discerned, one composed of microblades, microblade core tablets, microblade core facet rejuvenation flakes, and flakes centered on Feature 11, the other to the west composed primarily of flakes. No retouched items are found within 50 cm of Feature 11, but a burin and a spall scraper is located within the drop zone (Figure 9.21).

Reuse potential is considered low, but potential for disturbance after primary deposition is considered moderate to high. There is no associated oxidized sediment, but given the very limited surface area, interpretation is difficult. This charcoal may have been dislocated from a hearth located to the north (unexcavated area).

Figure 9.28 Feature 11 plan view, view grid north.

Feature 12 (hearth)

Feature 12 is a sub-circular hearth, defined by a discrete oxidized loess lens with charcoal fragments and burned bone (Figures 9.29-9.31). Feature 12 is 90 cm across along its longest axis (northwest to southeast), and 70 cm across along its shortest axis (northeast to southwest), with a surface area of 1.98 m^2. Cross section is lenticular (see Figures 9.30-9.31), indicating a maximum thickness of 9 cm, thinning towards the edges. No cobbles were found in direct association with the feature. Bone was concentrated within the hearth and a scatter of disarticulated large bone fragments was found about 1 m southeast of the southern edge of Feature 12, however the area between had little bone. A number of large possibly burned or brown-charred bone fragments were found directly within the hearth (measuring up to 15 cm long). Calcined bone fragments were found in two clusters, one at the far western edge, and one near the center. These clusters were about 5-7 cm in diameter. Numerous charcoal fragments were found within the hearth at all levels, however they seemed to be concentrated at the base of the hearth.

The boundary for this feature is very well defined, and no evidence of smearing is present, however the charcoal from Feature 8 may derive from this feature, which could constitute dispersal of the charcoal. The oxidization is considered very strong, and is richly colored, and the outer edge is discrete. Compared with the other hearths, this hearth is charcoal rich. Three 3-pointed charcoal samples from within the feature were collected. One of these samples contained two twig fragments submitted for wood identification. Both twigs were *Salix* sp. (see Appendix 4). They were submitted for dating, yielding a radiocarbon date of 8820±50 BP (β-183109). The matrix was catalogued in five bags due to the mass of oxidized sediment and the location within several 0.25 m^2 quads.

A number of features were located near Feature 12: Feature 18 hearth is located about 1.6 m northwest (centroid to centroid) and 0.8 m northwest (between nearest oxidized edges). The charcoal fragments designated Feature 8 may have derived from this hearth as the charcoal fragments are similar in size and shape. However, there is no smearing of the Feature 12 oxidized lens, and no large charcoal fragments breach the oxidization edge. The distribution of artifacts and fauna suggests a single occupation surface, and dates derived from this feature are likely more accurate than those derived from scattered charcoal fragments found in Feature 8, directly to the west.

Faunal remains associated with Feature 12 were collected in 21 provenience units, with a total of 92 bone fragments weighing 181.0 g. The faunal scatter was centered (by weight density isopleths, see Figure 6.12) on Feature 12. Mean weight per fragment is low, and fragment density and weight density is similar to the average of all hearths. The maximum dimension observed was 12.6 cm, with mean and median maximum dimensions per lot of 4.1±3.2 cm and 3.6 cm respectively. The only identifiable bone fragment within Hearth Feature 12 was a large artiodactyl L femur fragment (supracondyloid fossa and surrounding diaphysis, including part of the lateral supracondyloid crest). Fourteen of the 21 provenience units were identified as large to very large mammals, and five of those were identified as very large mammals. No small or medium sized mammal bones were recorded. Faunal shape was primarily long bone, unidentified, with some flat bone fragments. 14% of the remains (by weight) are burned, typically black or brown charred.

Faunal cluster F6b is centered on Feature 12, and of the three features nearby (Feature 8, Feature 12, and Feature 18), the faunal cluster most likely is directly associated with Feature 12 (see Chapter 6, Figure 6.12-6.13). Feature 12 contains more burned bone than Feature 18 (14%

Figure 9.29 Feature 12 plan view, view grid north.

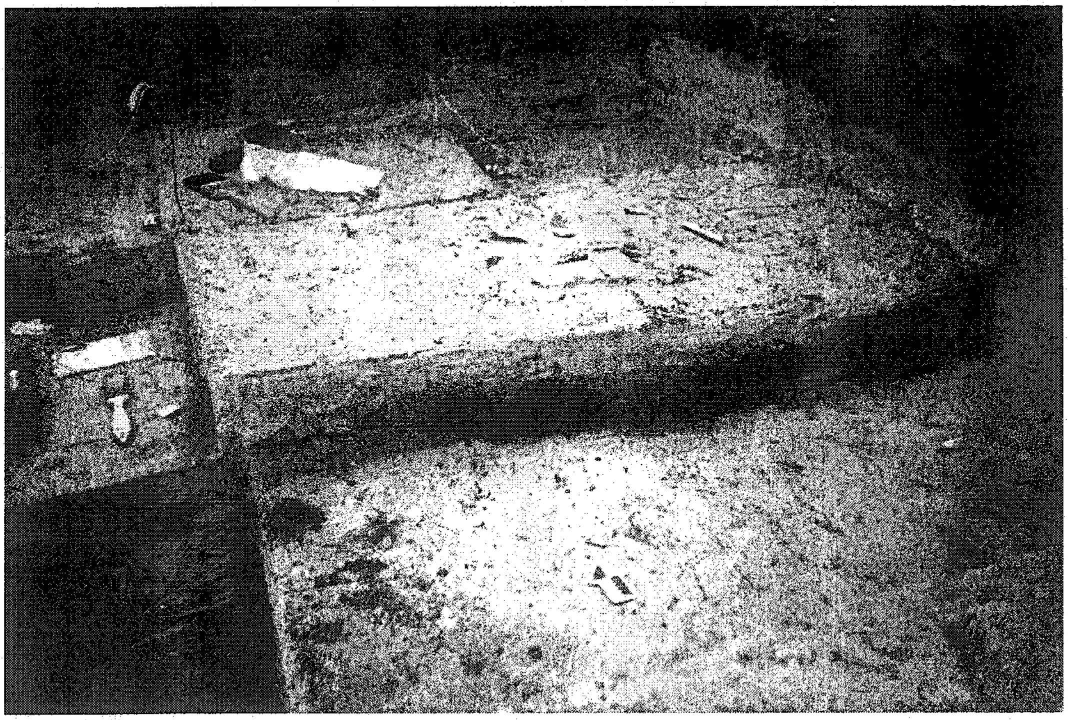


Figure 9.30 Feature 12 cross section, view grid north.

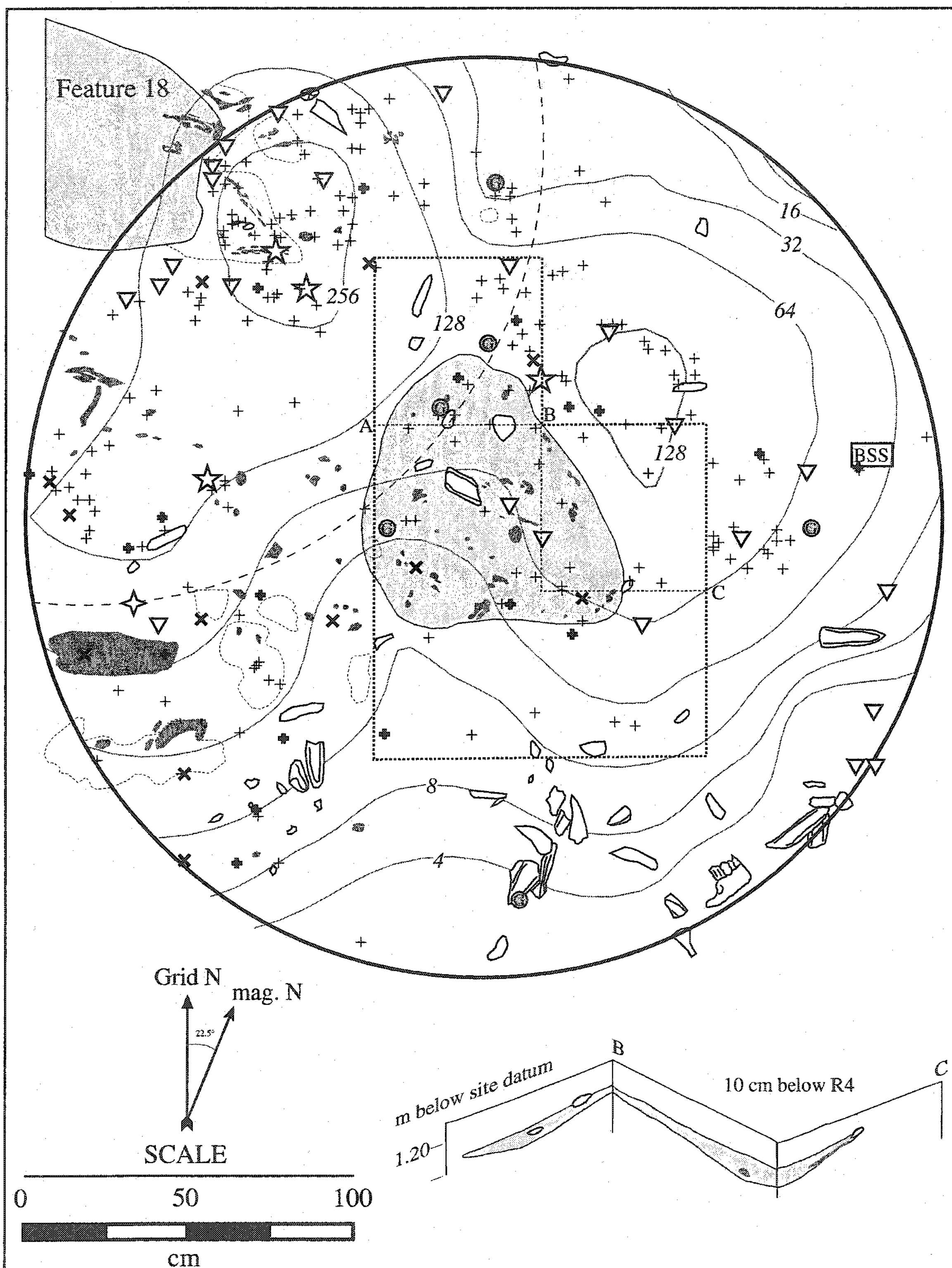


Figure 9.31 Feature 12 plan view and cross sections.

vs. <1%). This faunal cluster is interpreted as a processing area, characterized by low average weights, high %long bone weights, high %burn weights, high %appendicular specimens, and high degree of fragmenation. However, this cluster is the most dissimilar from other processing areas in terms of high %shaft weight and high %upper limb bones. A number of specimens were found within the drop zone, including Bison R distal metacarpal, Cervus R naviculo-cuboid, and large artiodactyl R tibia fragment (tibia crest and diaphysis), unidentified vertebra, and tooth enamel fragments. Faunal cluster F6a lies about 50 cm to the south of Feature 12, and there is a sharp decline in lithic items south of the hearth sufficient to suggest a boundary in activity areas, leading to the demarcation of clusters F6a and F6b (see Chapter 6 for a detailed discussion).

Lithic clusters were found on three sides of Feature 12, the largest to the northeast (Subarea C3), a closer cluster to the east (Subarea C4), and a more diffuse cluster to the west (Subarea C2) (Figure 9.31). Of these three clusters, only the northeast cluster is not also within the drop zone of Feature 18. Even with numerous lithics distributed in this area, they form a wishbone shaped pattern around the hearth (to the north) leaving the hearth itself with relatively few lithic items. Tools located within the drop zone include modified microblades, microblade core tablets, microblade core facet rejuvenation flakes, modified flakes, burin spalls, and a spall scraper. Five gastrolith clusters are also situated with this hearth, and three are embedded within or very near its matrix (see Chapter 6).

Reuse potential for Feature 12 is considered low, and the potential for post-depositional disturbance is considered moderate. The boundary of the oxidized silt is very discrete, and the large charcoal fragments and stained silt of Feature 8 is within a meter of Feature 12. The lithic artifacts are clustered in a wishbone-like pattern (Figure 9.31), with relatively high artifact densities. The proximity of Feature 12 to Feature 18 (dating to perhaps an earlier occupation, see Chapter 5) could indicate use of this area by multiple occupations. Given the spatial distribution, faunal patterning, and radiocarbon dates, it is possible that Feature 18 may represent an earlier occupation where lithic maintenance/microblade production within Subareas C2 and possibly C1 occurred, followed by a later occupation associated with Feature 12, faunal concentrations F6a and F6b, and lithic maintenance/microblade production in Subareas C4 and possibly C2.

Flotation of all Feature 12 sediments yielded a 29.6 g light fraction and a 20 g heavy fraction. The light fraction included 29 bud tips or complete buds and numerous charcoal fragments. The heavy fraction included 28 burned bone fragments, calcined, black, and brown charred, for a total weight of 3.5 g, and 3 subrounded pebbles weighing 1.4 g, the largest pebble is 1.2 cm diameter.

Feature 13 (hearth)

Feature 13 is a sub-circular hearth, defined by a discrete oxidized loess lens with charcoal and bone fragments (Figures 9.32-9.34). Feature 13 is 112 cm across along its longest axis (northwest to southeast) and 60 cm across along its shortest axis (northeast to southwest), with a surface area of 2.11 m^2. Cross section is lenticular (see Figure 9.33), indicating a maximum thickness of 7 cm, thinning towards the edges. No cobbles were found in direct association with the feature. Bone fragments were found at the southern edge and at the north central part of the oxidized hearth area, and charcoal concentrations were found at several places within Feature 13.

The boundary for this feature is well defined, and no evidence of smearing is present. The oxidization is considered moderate, and the outer edge is discrete. Compared with the other hearths, this hearth is charcoal poor. A burned twig was found directly within Hearth 13, and was submitted for wood identification. This specimen was identified as vitrified *Alnus* sp. (see Appendix 4). The twig was submitted for radiocarbon dating, and yielded a date of 8900±40 BP (β-181679). The matrix was catalogued in two bags. Feature 14 is located about 2 m to the southeast from hearth centroids, and 1 m away from the nearest oxidized perimeters. Only one small charcoal fragment was found between these hearths.

Faunal remains associated with Feature 13 were collected in four provenience units, with a total of 7 fragments weighing 32.2 g. Faunal cluster F9 is not considered directly associated with Feature 13, but rather with Feature 14 (see below), but a few bones were located within Feature 13 (Figure 9.34). Mean weight per fragment is high relative to hearth averages in Component 3, and weight density is low compared to other hearths (22 vs. 138 g/m^2). The maximum dimension observed was 9.1 cm, with mean and median maximum dimensions per lot of 5.1±3.5 cm and 5.0 cm respectively. No identifiable specimens were found directly associated with Feature 13. All of the bones were identified as large to very large mammals. No small or medium sized mammal bones were recorded. Faunal shape consists of primarily long bone and unidentified bone fragments. No burned bones were found in Feature 13.

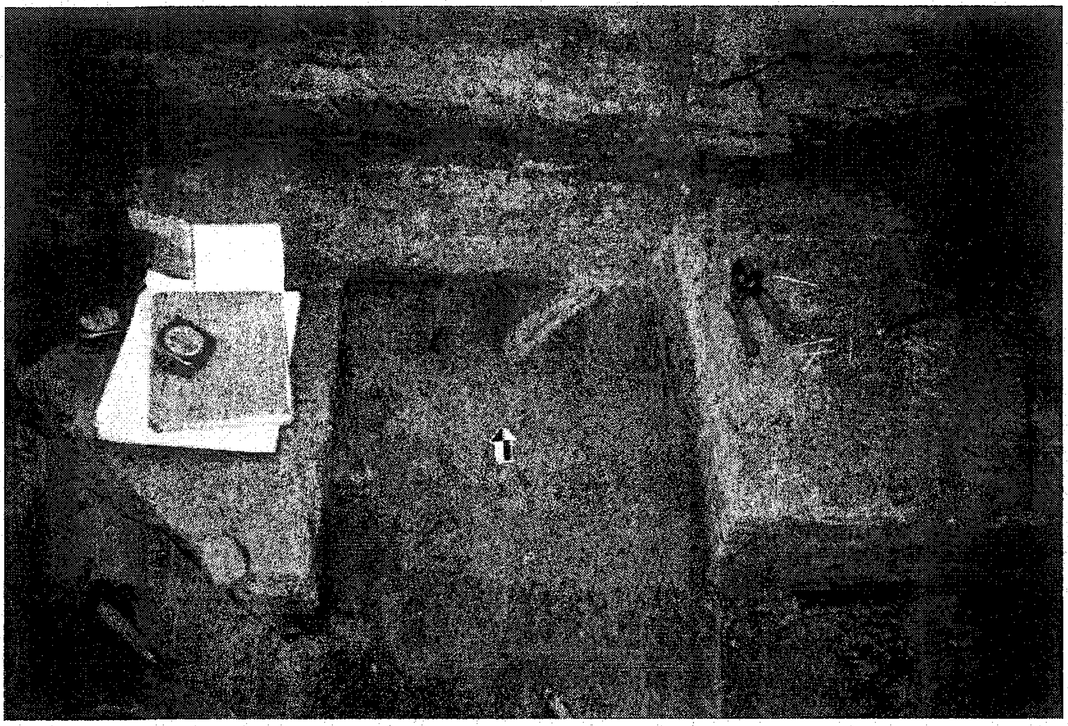


Figure 9.32 Feature 13 plan view (2002 excavation), view grid north.

Figure 9.33 Feature 13 cross section, view grid north.

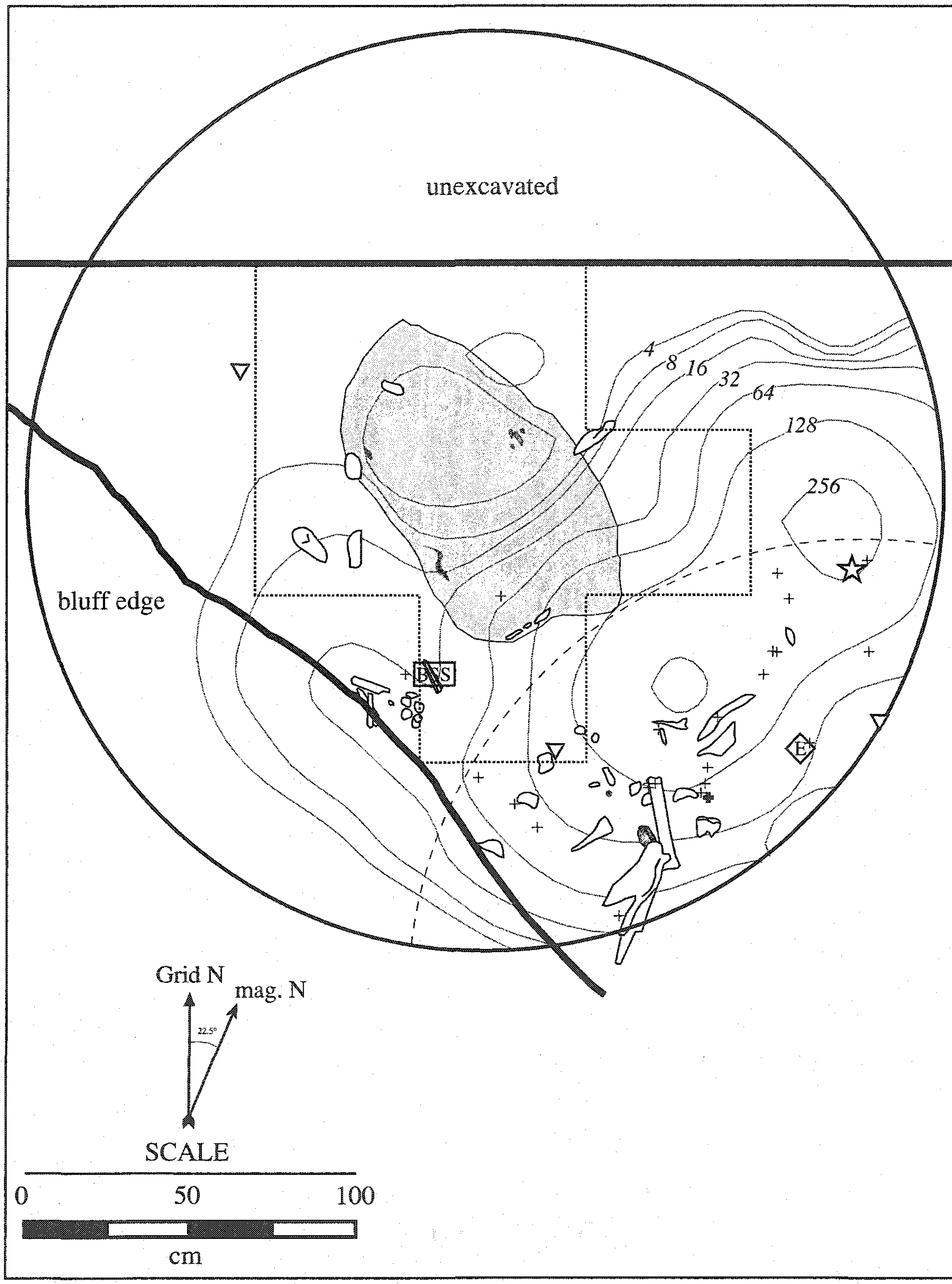


Figure 9.34 Feature 13 plan view.

A lithic cluster was located about 25 cm to the southeast (Subarea D1), though this also lay within the Feature 14 drop zone, and may be associated with either or both features (Figures 9.34, 9.37). The area to the west, northwest and northeast were generally devoid of lithic materials. Lithic tools located within the drop zone include modified microblades, a broken short axis beveled flake, a microblade core tablet, modified flakes, and a spall scraper.

Reuse potential for Feature 13 is considered relatively low given the discrete nature of the oxidized silt, the limited spatial clustering of lithic artifacts, bone fragments, and other cultural material. The feature does not exhibit smearing, and few large charcoal fragments were found nearby.

Feature 14 (hearth)

Feature 14 is a hearth, defined by a discrete oxidized loess lens with charcoal and bone fragments (Figures 9.35-9.37). Feature 14 is 123 cm across along its longest axis (east to west) and 45 cm across along its shortest axis (north to south), with a surface area of about 1.74 m^2. Since the hearth was discovered eroding out of the bluff face in 2002, the east west measurement should be seen as a minimum. Based on the other hearth plans, this hearth likely measures approximately 133 cm across from east to west. This would yield a surface area estimate of 1.88 m^2. Cross section is lenticular (see Figures 9.36-9.37), indicating a maximum thickness of about 6 cm, thinning towards the edges. No cobbles were directly associated with this feature. Calcined bone was concentrated in the hearth in a number of clusters, one near the eroding southern edge and two near the west-center. Larger unburnt or possibly burnt bone was found throughout the hearth feature. Numerous charcoal clusters were found throughout the hearth.

The boundary for this feature is well defined, and no evidence of smearing is present, however the overall outline resembles an hourglass, unique among the other hearths, which were generally sub-circular. The oxidization is considered strong, and the outer edge is discrete. Compared with the other hearths, this hearth is charcoal rich. Six 3-pointed charcoal samples directly associated with Feature 14 were collected, and the matrix was catalogued in three bags. One of these samples was submitted for identification and dating (UA2002-062-0889). Two fragments within this charcoal sample were identified as *Salix* sp., one was well preserved, the other broke into powder (see Appendix 4). This sample was submitted for dating, producing a radiocarbon date of 8580±40 BP (β-181680). This assay appeared too young given the date on the adjacent Hearth Features 13 and 16 (8900 and 8830 BP, see below) and the general suite of dates for Component 3 within two standard deviations of one another (between 8800 and 9100 BP, see Chapter 5). A second sample was submitted for dating from the 2003 excavated area of Hearth 14. This second sample was situated further back from the eroding bluff edge. The sample produced a radiocarbon date of 8760±40 BP (β-191558), which was more in line with the other samples. Details about these dates and their interpretation are presented in Chapter 5.

A number of features are located near Feature 14: Feature 13 is located 2 m to the northwest from hearth centroids and 1 m away from the nearest oxidized perimeters, and Feature 16 is located 1.3 m to the southeast from hearth centroids and 0.6 m from the closest oxidized perimeters. The distribution of artifacts and fauna suggests a single occupation surface between Features 14 and 13 and 14 and 16. No charcoal fragments were found between Features 14 and 16. Furthermore, the depths of Features 14 and 16 are identical and their proximity further supports a single occupation.

Faunal remains associated with Feature 14 were collected in 21 provenience units, with a total of 141 bone fragments weighing 300.4 g. The faunal cluster F9 was centered about 50 cm to the northwest of Feature 14. Mean weight per fragment is consistent with the other hearths, but weight density is the highest among all clusters except Feature 1. The maximum dimension observed was 27.0 cm, with mean and median maximum dimensions per lot of 4.8±7.5 cm and 1.8 cm respectively. Identifiable bone fragments in direct association with Feature 14 include a *Cervus* L proximal metacarpal, and a very large mammal vertebra fragment. Four of the 21 provenience units were identified as very large mammals. No small or medium sized mammal bones were recorded. Faunal shape is relatively equally divided into long, irregular, and unidentified bones. 13% of the fauna (by weight) are burned, typically brown and black charred.

Faunal cluster F9 was directly associated with Feature 1 (see Chapter 6, Figures 6.12-6.13). This cluster is interpreted as a marrow processing area, characterized by low average weight, low %shaft weight, relatively higher %long bone weights, higher %burn weights, skeletal units types of primarily lower limb bones, and high degree of fragmentation (see Table 6.6). A number of specimens were found within the drop zone, including *Cervus* R scaphoid, R 2nd and 3rd carpal, L proximal metacarpal, L proximal radius, and large artiodactyl L scapula, and vertebra fragment. Just outside the drop zone to the northeast and east lay a *Cervus* L proximal

Figure 9.35 Feature 14 plan view (2002 excavation), view grid north.

Figure 9.36 Feature 14 cross section, view grid east (note flagging for Component 4 artifacts [upper] and Component 3 artifacts [lower]).

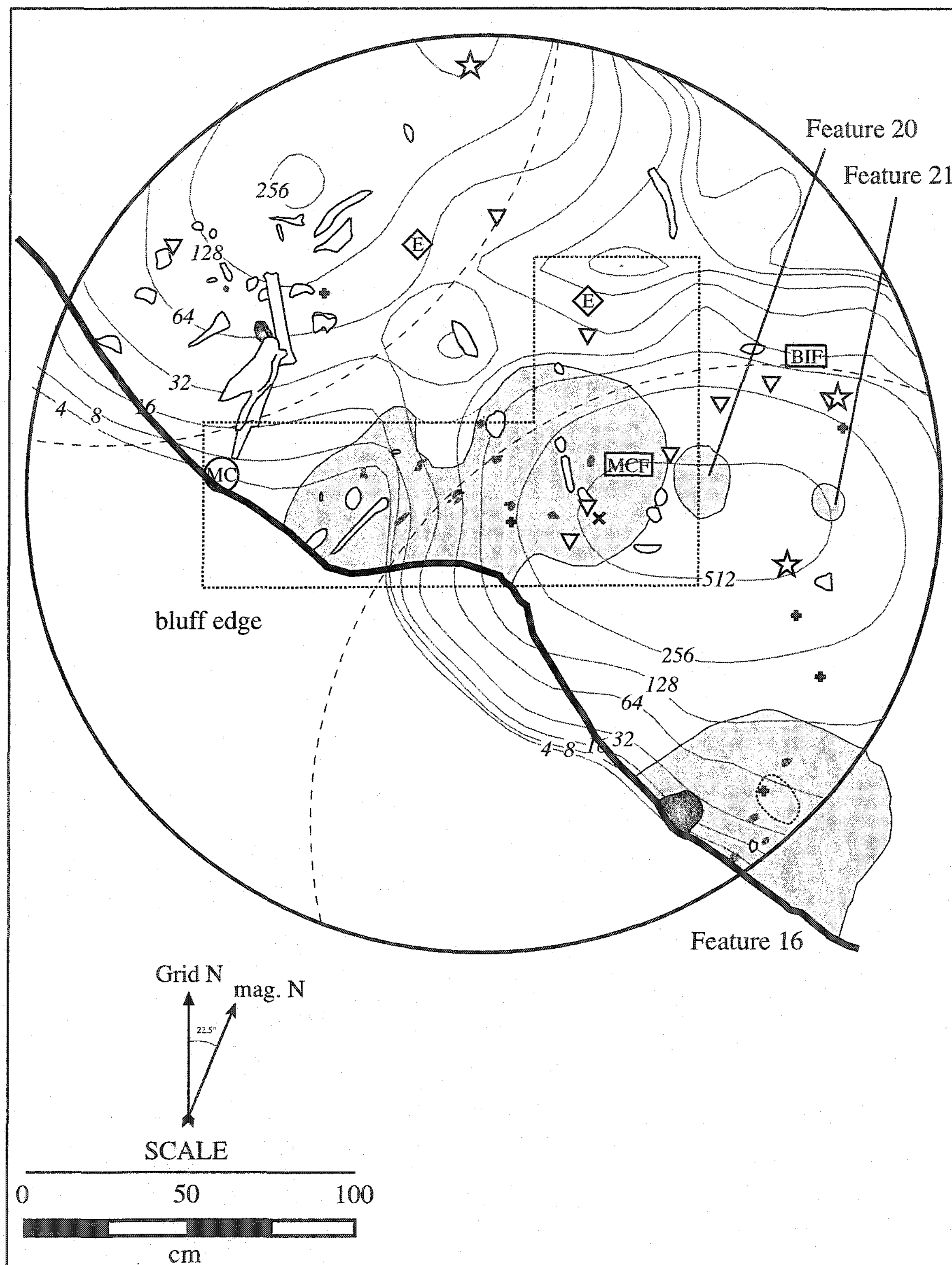


Figure 9.37 Feature 14, 20, and 21 plan views.

metacarpal, R cuneiform, R naviculo-cuboid, L calcaneus, L distal metatarsal, R distal metatarsal, and large artiodactyl L femur medial condyle fragment.

Lithic clusters were found 15 cm to the east (Subarea D2) and 80 cm to the northwest (Subarea D1). The northwest cluster may be associated with Feature 13, and the east cluster is generally situated between Features 14 and 16. Lithic tools located within the drop zone include modified microblades, a microblade core, microblade core fragment, microblade core tablets, modified flakes, a short axis beveled flake, a biface, and burin spalls.

Reuse potential for Feature 14 is considered moderate to low. The boundary of the oxidized silt is relatively discrete, no large charcoal fragments were found nearby; however, the boundary of the oxidized silt shows an irregular border, perhaps the result of two feature uses, one a short period after the other.

Flotation of all Feature 14 sediments yielded a 13.8 g light fraction included 1 *Chenopodium album* seed, 4 bud tips, 1 possible graminoid seed, possible leaf structures, and numerous charcoal fragments and a 6.0 g heavy fraction including 38 bone fragments, 17 calcined, 9 brown charred, 1 black charred, and 1 reddened, for a total weight of 1.3 g (Gelvin-Reymiller 2004).

Feature 15 (burnt log fragments)

Feature 15 is unlike any other feature discovered at the site (Figure 9.38). This feature is a compressed burnt log or large branch situated on the slope between Areas A and B (in Block G). Part of the log is still visible in the profile, and thickness is estimated at between 2 and 3 cm.

The excavated portion of the log is 125 cm northeast to southwest, and 27 cm northwest to southeast. As the log continued north, the 125 cm measurement should be seen as minimum. This feature was catalogued in one bag, and remains undated. Two bone fragments were found associated with this log, one lying directly on top of it, an epiphysis and diaphysis of a large mammal long bone, and another one found in the screen from the same quad, an unidentified medium to very large mammal bone fragment. Both fragments were considered possibly burnt, but displayed no charring. No lithic artifacts were found nearby, and the position of this feature on the slope between two occupation areas makes interpretation difficult. The presence of the feature within Y4a, level 3 and the associated bone fragments suggests that Feature 15 is likely related to Component 3.

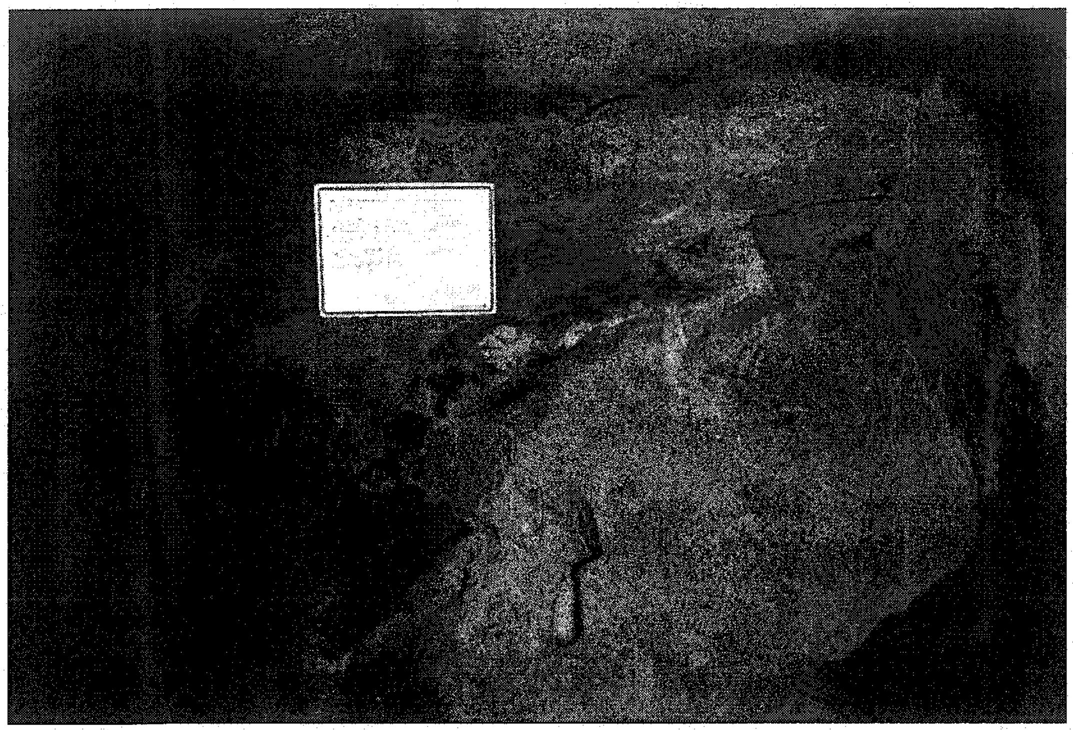


Figure 9.38 Feature 15 plan view, view north.

Feature 16 (hearth)

Feature 16 is a sub-circular hearth, defined by a discrete oxidized loess lens with associated charcoal fragments, burned bone, and a cobble (Figures 9.39-9.41). Feature 16 is 80 cm across its longest axis (northwest to southeast) and 50 cm across along its shortest axis (northeast to southwest), with a surface area of about 1.26 m^2. Since the hearth was discovered eroding out of the bluff face in 2003, the northeast to southwest measurement should be seen as a minimum. Based on the other hearth plans, this hearth likely measured 80 cm northeast to southwest, with a surface area estimate of about 2.01 m^2. Cross section is lenticular (Figures 9.40-9.41), indicating a maximum thickness of 5 cm, thinning towards the edges. A large cobble (14 cm diameter) was located at the bluff edge at the southwestern edge of Feature 16. Bone fragments were found throughout the hearth.

The boundary for this feature is well defined, and no evidence of smearing is present. The oxidization is considered moderate, and the outer edge is discrete. Compared with the other hearths, this hearth is moderately rich with charcoal. Six 3-pointed charcoal samples directly associated with Feature 16 were collected, one yielding a radiocarbon date of 8830±50 BP (β-181678). The matrix was catalogued in two bags.

Feature 14 is located about 1.3 m to the northwest from the hearth centroid and 0.6 m from the closest oxidized perimeters. The spatial distribution of artifacts and fauna and the two oxidized lenses suggests a single occupation in this area.

Faunal remains associated with Feature 16 were collected in 6 provenience units, with a total of 23 bone fragments weighing 240.4 g. A faunal scatter was situated to the northeast and northwest of Feature 16 (Figure 9.41). Mean weight per fragment is the highest (except for Feature 1), and fragment density is much lower than average (18 vs. 78 average for all hearths), suggesting predominance of a few numbers of larger bone fragments. The maximum dimension observed was 22.6 cm, with mean and median maximum dimensions per lot of 7.9±9.0 cm and 5.7 cm respectively. Identifiable bone fragments in direct association with Feature 16 include a *Cervus* R distal metatarsal (+75% diaphysis) and a large artiodactyl R femur medial condyle fragment. Three of the 6 provenience units were identified as very large mammals. No small or medium sized mammal bones were recorded. Faunal shape is primarily long bone fragments, and <1% of the remains were burned (by weight). This suggests that faunal processing probably did not take place at this hearth.

Faunal cluster F9 was located primarily to the north of Feature 16, and is associated with Feature 14 (see above, Chapter 6, Figures 6.12-6.13, 9.41). This cluster is interpreted as a marrow processing area, characterized by low average weight, low %shaft weight, relatively higher %long bone weights, higher %burn weights, skeletal units types of primarily lower limb bones, and high degree of fragmentation (see Table 6.6). A number of specimens were found within the drop zone, including a *Cervus* R distal metatarsal and L distal metatarsal.

A lithic cluster was found 50 cm to the north (Subarea D2), and this cluster may be associated with either Feature 16 or Feature 14, but it is in much closer proximity to the latter (Figure 9.41). Lithic tools located within the drop zone include modified microblades, a microblade core, microblade core fragment, microblade core tablets, modified flakes, and burin spalls.

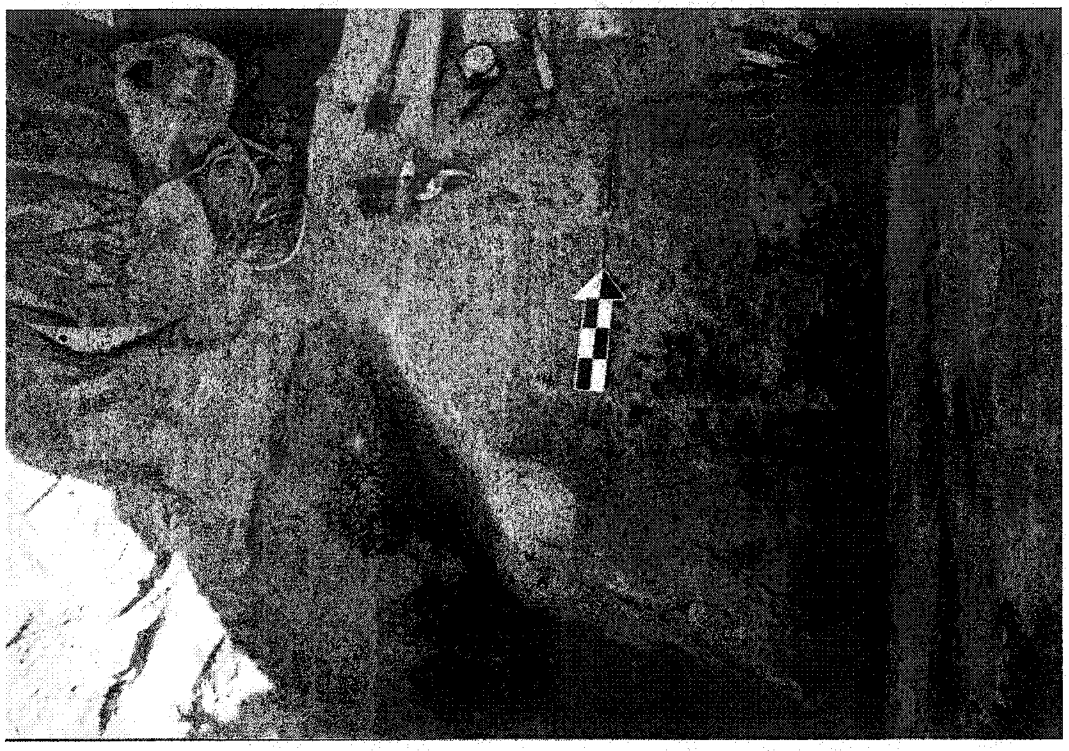


Figure 9.39 Feature 16 plan view, view grid north.

Figure 9.40 Feature 16 cross section, view grid east.

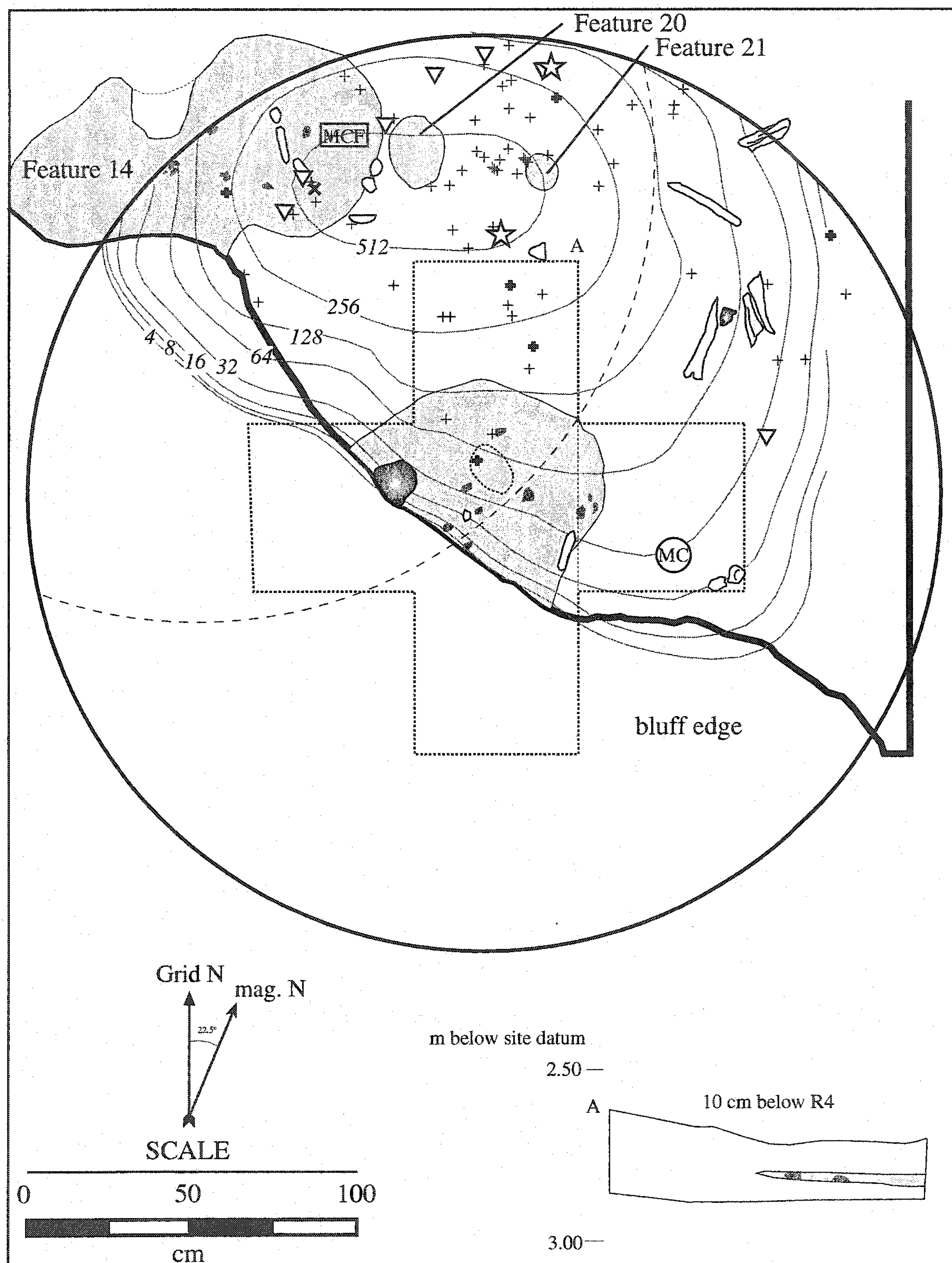


Figure 9.41 Feature 16 plan view and cross section.

A complete desiccated berry was found within Feature 16 (see Figure 9.42), screened along with burned bones from directly within the hearth (UA2003-54-1508, N39-50-40.00, E56.50-57.00, 50-57 cm below R4). This berry was tentatively identified by Alan Batten (Collections Manager, Herbarium of the University of Alaska Museum) as *Vaccinium vitis-idaea* (lingonberry). Less likely taxa include *Arctostaphylos uva-ursi* (bearberry) or *Empetrum nigrum* (crowberry). All three are edible, but *E. nigrum* is insipid and *A. uva-ursi* is mealy and generally tasteless (Hultén 1968: 716, 729, 731).

Reuse potential for Feature 16 is considered relatively low given the discrete nature of the oxidized silt and the limited spatial clustering of the lithic artifacts and bone fragments. The feature does not exhibit smearing, and few large charcoal fragments were found nearby.

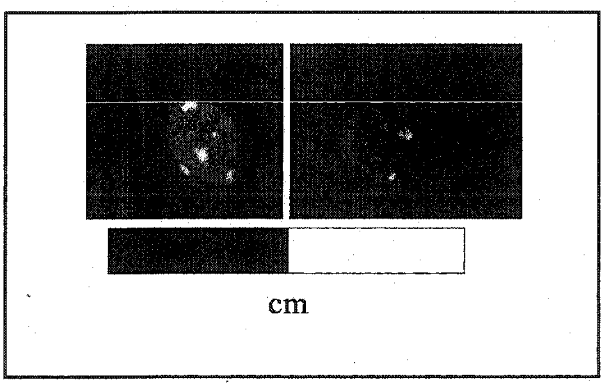


Figure 9.42 Lingonberry (*Vaccinium vitis-idaea*) from Hearth Feature 16, UA2003-54-1508

Feature 18 (hearth)

Feature 18 is a sub-circular hearth, defined by a discrete oxidized loess lens with charcoal fragments and burned bone (Figures 9.43-9.45). Feature 18 is 67 cm across along its longest axis (north to south) and 60 cm across along its shortest axis (east to west), with a surface area of about 1.26 m^2. Since the hearth continued into an unexcavated square to the west, the east-west measurement should be seen as a minimum. Based on the other hearth plans, this hearth likely measures approximately 95 cm across from east to west. This would yield a surface area estimate of 2.00 m^2. Cross section is lenticular (Figures 9.44-9.45), indicating a maximum thickness of 6 cm, thinning towards the edges. No cobbles were directly associated with this feature. Large concentrations of charcoal, ranging up to 20 cm long clusters, were found mainly in the eastern and southeastern sides of the hearth.

The boundary for this feature was moderately well defined, though the presence of the charcoal fragments to the southeast and the gradation from deeper oxidized areas in the center to gray charcoal-rich stained loess to the east (similar to Feature 8) suggests that some smearing may have occurred. Charcoal fragments extend to the south and they may be related to Feature 8. The oxidization is considered variable, from weak in the south and east to strong in the center and west. Compared with the other hearths, this hearth is very rich in charcoal. Sixteen 3-pointed samples from within Feature 18 were collected, one yielding a radiocarbon date of 9080±50 BP (β-183108) (see Chapter 5). The matrix was catalogued in four bags.

Feature 12 is located 1.6 m to the southeast of Feature 18 (centroid to centroid) and 0.8 m southeast (between nearest oxidized edges). The charcoal fragments designated Feature 8 may have derived from Feature 18, though they are more likely to be associated with Feature 12 given the distance between the main charcoal clusters (see Figure 9.45).

Faunal remains associated with Feature 18 were collected in 16 provenience units, with a total of 58 fragments weighing 75.4 g. Mean weight per fragment, fragment density and weight density is similar to other hearths (Table 9.1). The maximum dimension observed was 15.1 cm, with mean and median maximum dimensions per lot of 3.2±5.0 cm and 0.8 cm respectively. Identifiable specimens associated with Feature 18 include a *Bison* R distal metacarpal. Three of the 16 provenience units were identified as very large mammals, and one other was identified as medium to very large mammal. No small or medium sized mammal bones were recorded. Faunal shape was primarily long bone with few unidentified bone fragments, and only 1% of the remains were burned (by weight), suggesting that faunal processing may not have occurred at this hearth.

Faunal cluster F6b was situated primarily to the south of Feature 18, in association with Feature 12 (see Chapter 6, Figures 6.12-6.13). This cluster is not considered to be associated with Feature 18 and is discussed elsewhere. Other identified specimens within the Feature 18 drop zone are also within the Feature 12 drop zone. A small faunal concentration is centered 10 cm to the east of Feature 18, within the gray-stained charcoal rich sediment amid numerous charcoal fragments.

One lithic cluster was centered adjacent to Feature 18 to the east (Subarea C3) and one was centered 75 cm to the south (Subarea C2). Both lithic clusters located within the Feature 18

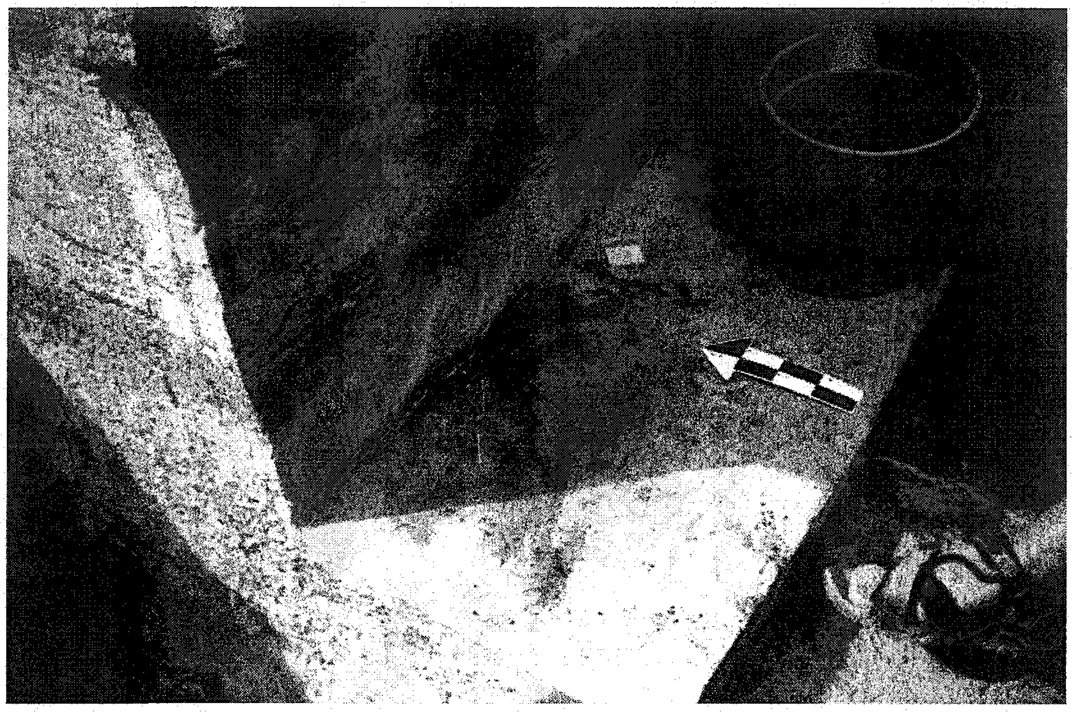


Figure 9.43 Feature 18 plan view, view grid northwest.

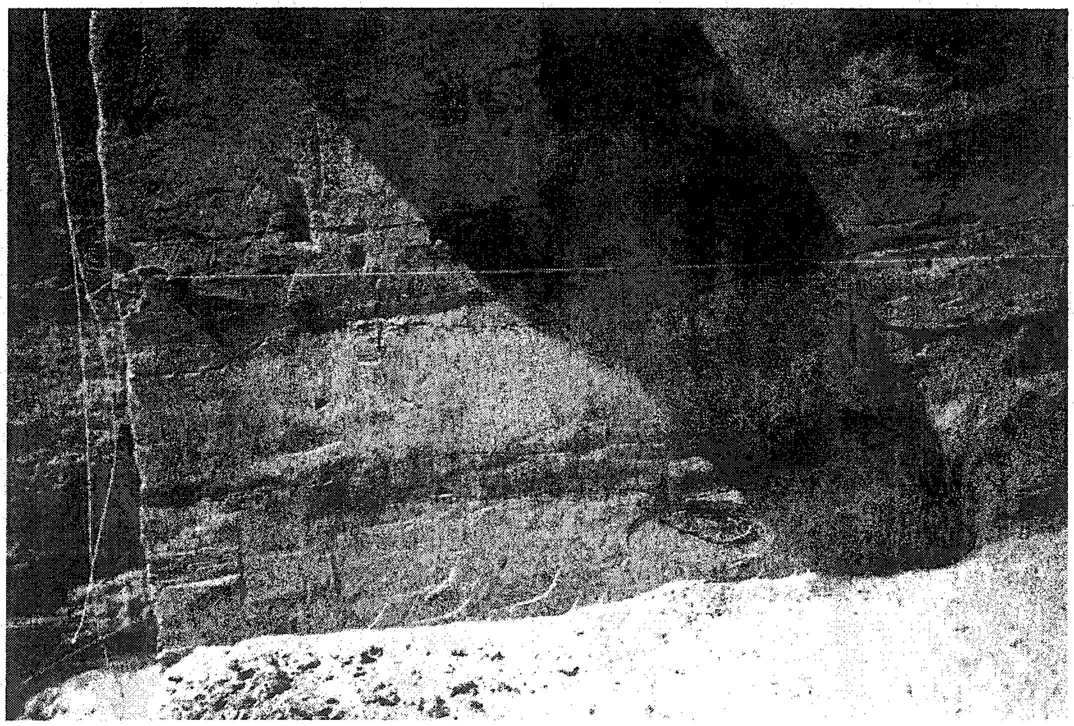


Figure 9.44 Feature 18 cross section, view grid west.

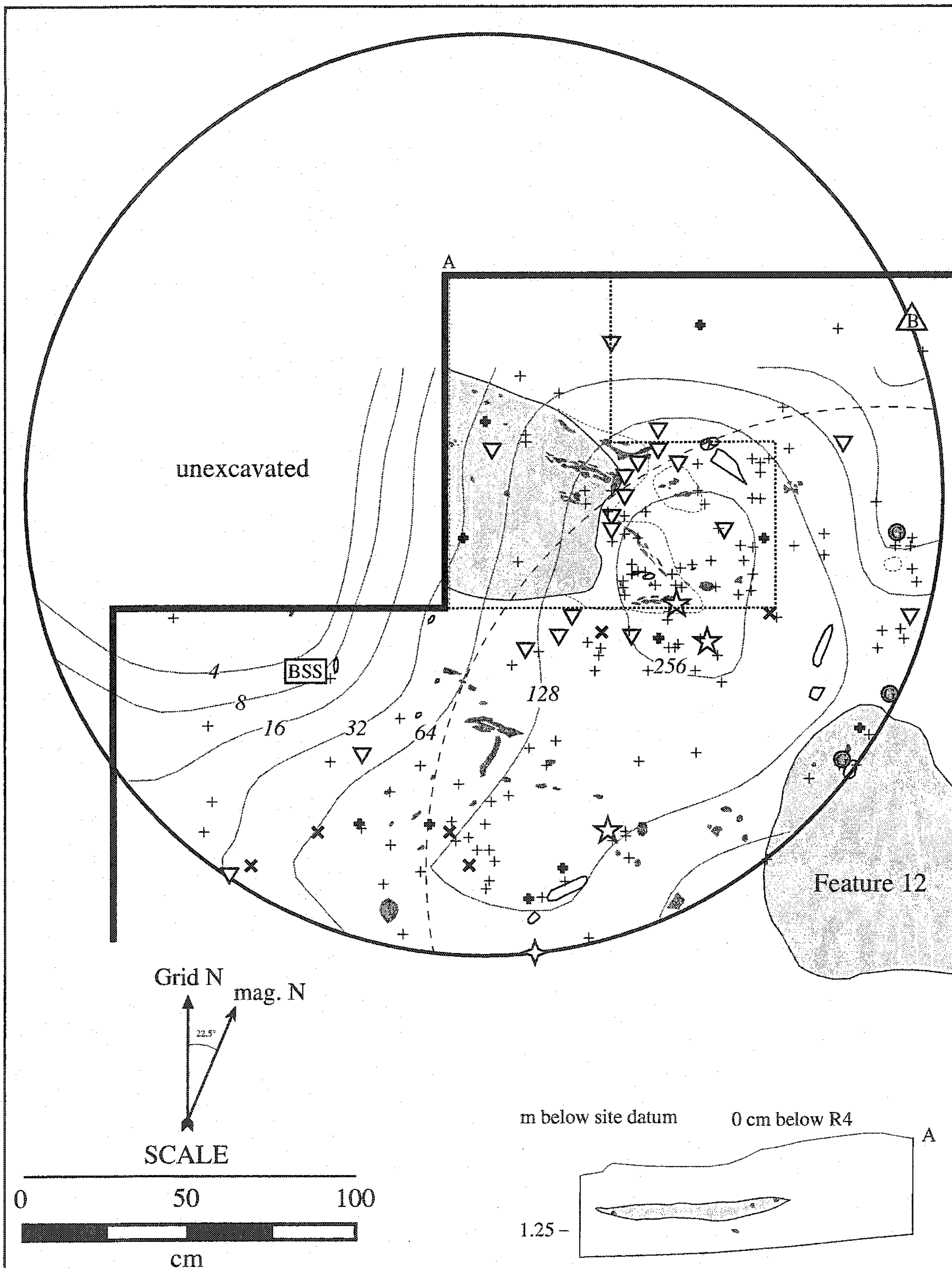


Figure 9.45 Feature 18 plan view and cross section.

drop zone are also within the Feature 12 drop zone, and one or both may relate to Feature 12, however the proximity of Subarea C3 and the absence of lithics to the northwest and north of Feature 18 suggests this may be associated with Feature 18.

Reuse potential for Feature 18 is considered moderate, and the potential for post-depositional disturbance is considered high. The boundary of the oxidized silt is somewhat diffuse, and the presence of large charcoal fragments and gray stained sediment to the east could indicate smearing. The radiocarbon dates of Feature 8 indicates contemporaneity with Feature 18 whereas it is significantly different from the date from Feature 12 (see Chapter 5), suggesting that the source of the scattered charcoal cluster (Feature 8) may be Feature 18. This scenario would indicate that after Feature 18 was used and abandoned, another occupation used this area, building Feature 12 and scattering the charcoal from Feature 18.

Other Features

In addition to the features described above, two other features were identified within Component 3 in Block Y, designated Features 20 and 21 (Figure 9.37). Both can be described as limited bright red (or orangish-red) stains, dissimilar to the oxidized hearth features observed in the same stratum. No charcoal fragments were associated with these features.

Feature 20 is an oval-shaped reddish stain, 23 cm diameter north-south and 15 cm diameter east-west, with a surface area of 0.10 m^2. A number of items were found within this stain, but there was no noticeable concentration of bones or lithics within them and in the surrounding area. Eleven flakes, 2 microblades, and three faunal provenience units were found within this stain. Within the three provenience units were approximately 17 very small bone fragments, and the faunal provenience units weighed less than 0.1 g each. The bone fragments were highly fragmented and unidentifiable, with generic breakage, possibly burned, with one fragment calcined.

Feature 21 is a circular reddish stain, approximately 10 cm diameter, with a surface area of 0.03 m^2. Only five flakes and two microblades were found directly within this feature, and no bones or charcoal were found in association.

Both features were relatively shallow, approximately 2-3 cm thick. The small size and lack of charcoal renders interpretation of these stain difficult. The red color is different in hue than the oxidized hearth areas, and is considered generally a stronger and brighter red. The outer edge of Feature 14 is located about 5 cm to the west of Feature 20, though the oxidized edge of the former feature does not appear similar to the color of Feature 20. It is possible that Features 20 and 21 represent clusters of red ochre finely ground or otherwise interspersed within the matrix, though no ochre fragments were identified during the excavation in this immediate area.

Component 4 Feature

A single hearth feature was associated with bone and lithic artifacts of Component 4, from 8-12 cm below the bottom of stratum R4.

Feature 7 (hearth)

Feature 7 is a hearth located from 8-12 cm below the bottom of Y4 and about 4-8 cm above Component 3 materials in Block Q (Figures 9.46-9.48). Feature 7 was different from the Component 2 and 3 hearths in a number of aspects. First, it was considerably larger in lateral dimension. Feature 7 is 130 cm across along its longest axis (northwest to southeast) and 85 cm across its shortest axis (northeast to southwest), with a surface area of 3.47 m^2. The other completely excavated feature surface areas averaged 1.57±0.51 m^2, ranging from 0.80 to 2.29 m^2. Second, there were two large log-like charcoal fragments oriented parallel to each other (oriented east-west) at a distance of 5 to 23 cm apart. No other large charcoal fragments (i.e., maximum dimension over 10 cm) were recovered from the other hearths. These burnt wood fragments are about 105 cm long and a maximum width of 8 cm. A third similarly sized burnt wood fragment (70 cm long and 7 cm wide) is present 53 cm to the east-southeast of the other two. Large charcoal fragments are situated between the third burnt wood piece and the oxidized area.

The plan view of this hearth shows a roughly circular oxidized loess south of the two burnt fragments, an "arm" of oxidized silt extending to the southwest, with an area of charcoal rich (but unoxidized) loess between them (Figures 9.47-9.48). Bone fragments were concentrated at the extreme eastern end of the circular oxidized loess and within the unoxidized silt between this and the third burnt wood fragment to the east. Total thickness is estimated at 5 cm, thinning towards the edges. No cobbles were found associated with this feature.

The boundary of this feature was moderately well defined, though the presence of charcoal fragments to the east and the unoxidized charcoal-rich area between the oxidized areas suggests that some post-fire disturbance may have occurred. Compared with the Component 3 hearths, this hearth is charcoal rich. Eight 3-pointed charcoal samples from within Feature 7 were collected, and fragments from the southern large charcoal fragment were submitted for dating. This yielded a radiocarbon date of 8660±40 BP (β-167396) (see Chapter 5). The matrix was catalogued in one bag.

Faunal remains were collected in 10 provenience units, with a total of 130 bone fragments weighing 65.4 g. Mean weight per fragment is low, lower than the average of the hearths in Component 3, the fragment density is near the Component 3 average, but the weight density is low, much lower than the Component 3 hearth average (44 vs. 143). This suggests that the faunal fragments are small and relatively few compared to Component 3 hearths. The maximum dimension observed was 5.6 cm, with mean and median maximum dimensions per lot of 2.2±1.9 cm and 1.3 cm respectively. No identifiable specimens were found directly associated with Feature 7. Five of the 10 provenience units were identified as large to very large mammals. No small or medium sized mammal bones were recorded.

The lithic concentration (Subarea G) is located about one meter south of Feature 7, and the only tool located in this area is a retouched blade (see Chapter 7). There is a clear spatial separation between the bone fragments, directly associated with the hearth, and the lithic concentration, about 50 cm south of the faunal remains (Figure 9.48).

Reuse potential is considered low given the discrete nature of the hearth and the limited spatial clustering of lithic artifacts, bone fragments, or other cultural material. No features were found within this horizon (~8-12 cm below R4) in the area.

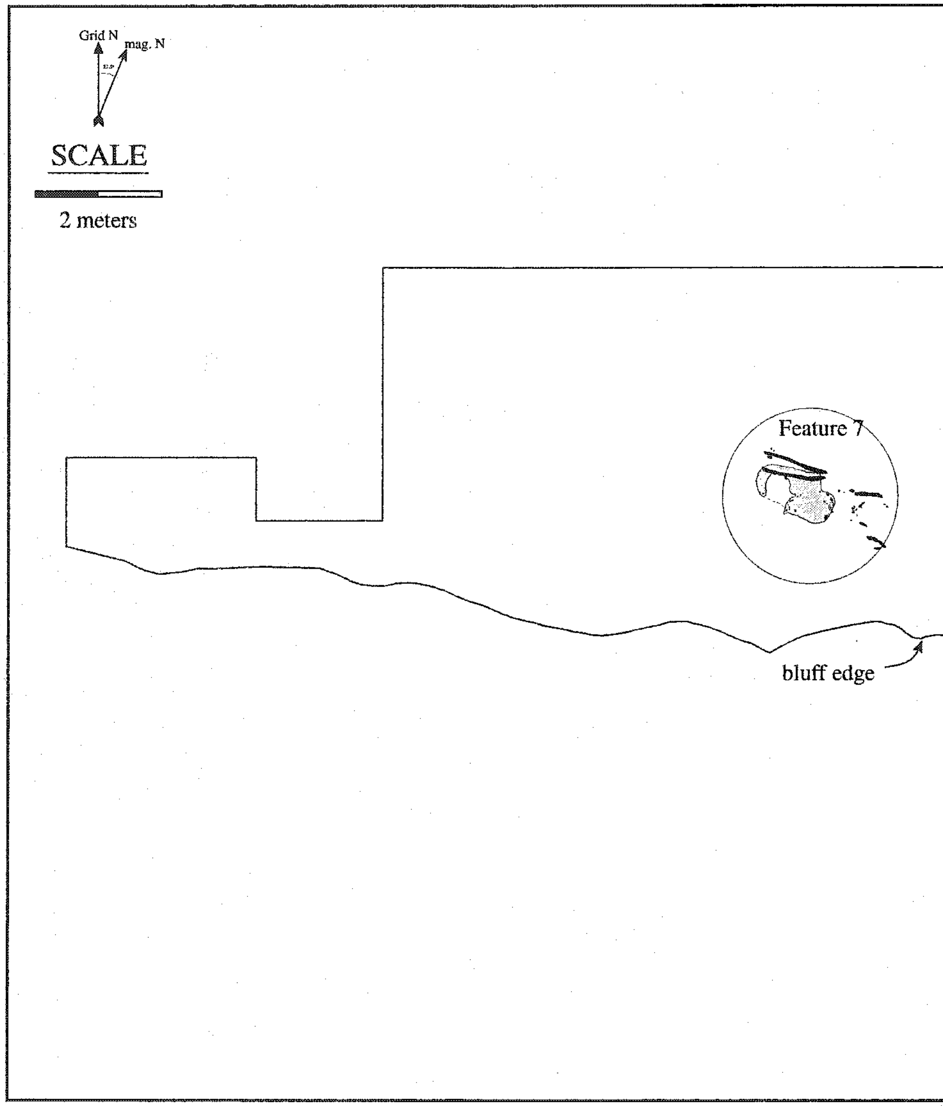


Figure 9.46 Component 4 feature distribution plan view.

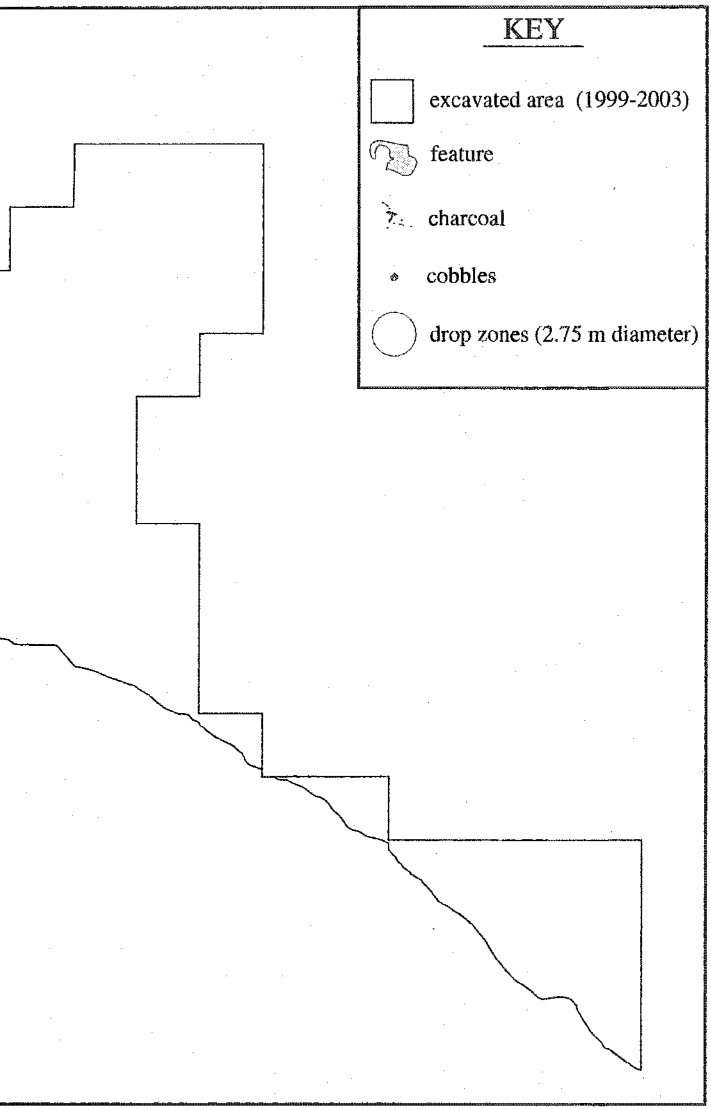

KEY
excavated area (1999-2003)
feature
charcoal
cobbles
drop zones (2.75 m diameter)

Figure 9.47 Feature 7 plan view, view grid south.

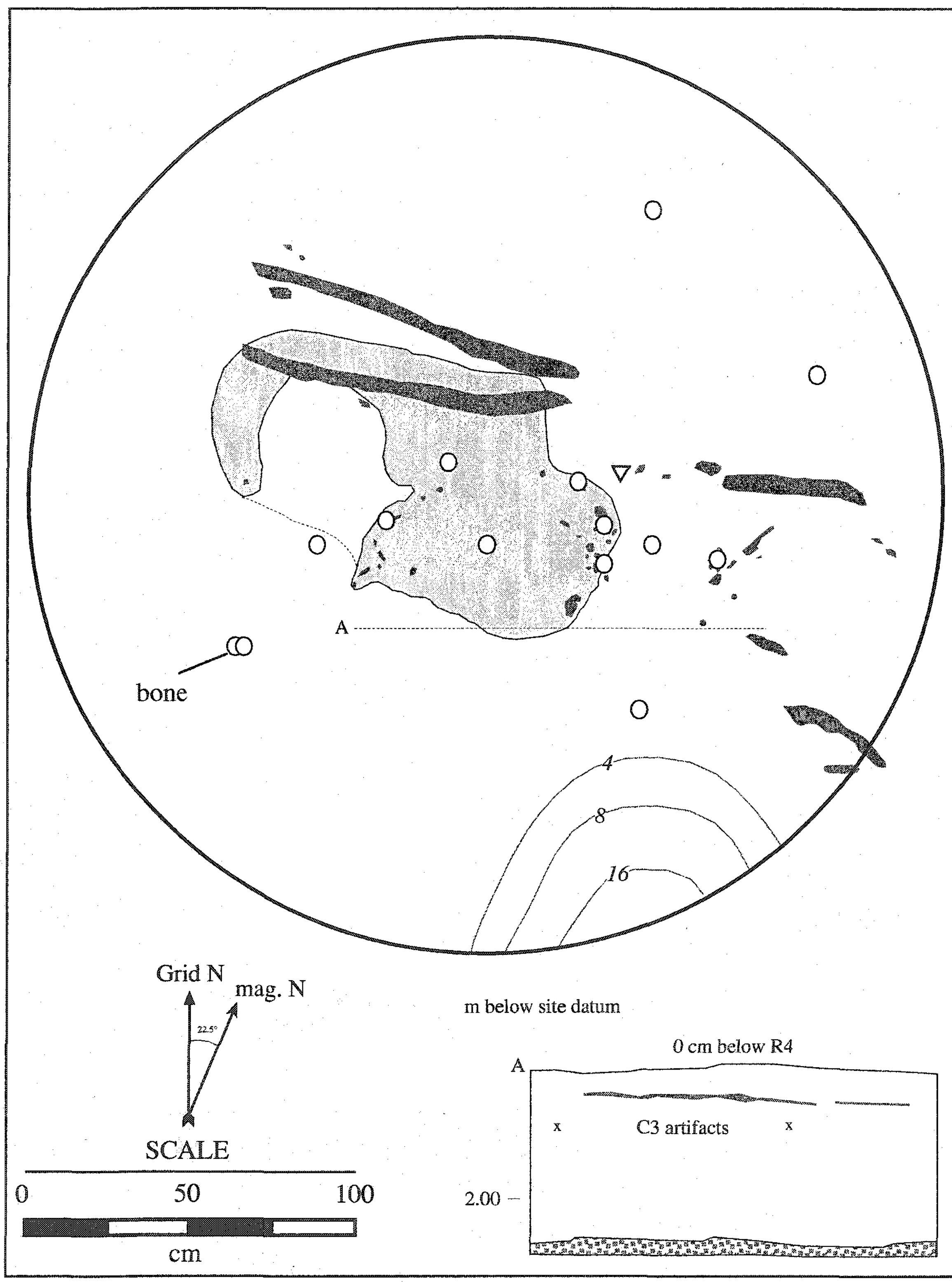


Figure 9.48 Feature 7 plan view and cross section.

Discussion

Hearth Morphology

The features identified as hearths (n=13) exhibit homogeneity in several morphological characteristics. The oxidized lenses were roughly circular in plan view, generally less than 1 m diameter, and were lenticular in cross section, suggesting similar manners of construction and use. The hearths were unlined, only a few had associated cobbles, and in no case did they encircle the hearth. All the cobbles were found at the surface or slightly buried, none were found near the bottom of the hearths. Feature 7 is the most divergent in morphology, in that three large burnt logs or branches were found adjacent to and within the oxidized area.

Surface area measurements are summarized here from the six completely excavated Component 3 hearths. Maximum thickness measurements summaries include the partially eroded hearths as all were visible in cross-section. The hearths are generally sub-circular, with the longest axis measuring 93.2±17.3 cm, the shortest axis measuring 61.8±9.6 cm, and a maximum thickness of 6.0±1.3 cm. The surface area average is 1.81±0.44 m^2. When hearth surface areas estimated for Component 3 truncated hearths are included (n=10), the surface area average is 1.83±0.35 m^2. These hearth features are therefore relatively uniform in morphology.

Hearthstones were generally lacking, and only two hearths had large cobbles associated with them (Features 1 and 16). No hearth was completely encircled by hearthstones, suggesting that these fires were quickly and expediently prepared. Charcoal fragments were found in all hearth features, and the sizes ranged up to over 2 cm in maximum dimension. During excavation, many charcoal fragments were identified as small twigs (complete in cross section) with diameters of around 0.5 cm. Identified hearth charcoal includes four *Salix* sp. specimens and one *Betula* sp. specimen (see below). Macrofossils found within the floated hearths include numerous bud tips or complete buds. This evidence suggests that the fuel for these hearths likely derived from local trees or shrubs.

The basins of the hearths were filled with charcoal, and had few or no associated thermally altered rocks (sometimes termed fire-cracked rocks) that would suggest stone boiling or indirect heating of foods (Leroi-Gourhan and Brezillon 1966; Carr 1991). This suggests that Gerstle River hearths were not used for these purposes.

In sum, hearth morphology suggests that the Component 3 and 4 hearths were likely used for the same purpose or a limited number of purposes given their similarities in surface area, plan view morphology, depth, and lack of lining or cobbles. With the possible exception of Feature 7, the hearths are nearly identical in morphology. Whatever tasks were directly associated with these hearths, the tasks did not result in different morphologies. These data do not suggest that specialized hearth-related activities occurred that would necessitate intensive or extensive burning (in an oven-like fashion). Regarding duration, each hearth was likely used for a short time for perhaps less intensive uses (i.e., for warmth, lighting, roasting, etc.) rather than for heavier uses like intensive cooking or boiling. Differences between Components 2 and 3 hearths cannot be made on the basis of morphology alone. The single Component 4 hearth, Feature 7, does exhibit some differences in morphology, namely with the presence of largely intact massive wood charcoal resembling logs or large branches.

Faunal Remains within Component 3 Cultural Features

Faunal shape, number of fragments, weight, and other variables derived from analysis of the faunal remains within each hearth may provide insight into hearth function. This section details data on those hearths with associated bone fragments from Components 3 and 4 (Features 1, 3, 5, 9, 10, 12, 13, 14, 16, and 18). Faunal remains were found directly associated with the charcoal scatter Feature 8 and are included here, but no bones were found associated with charcoal scatter Feature 11. The burnt log (Feature 15) is not considered in this section.

Bone of various burning types were found in all of the features listed above except Features 9 and 13, including calcined, black or brown charred, and unburned. The burned faunal remains are distinctly clustered around several of the hearths, Features 1, 3, 5, 10, 12, and 14, suggesting that these hearths may have been utilized differently than Features 9, 13, 16, and 18 (see Chapter 6, Figure 6.16). This demarcation will be used in the following analyses, with hearths classified as *processing hearths* and *other hearths*.

Faunal assemblages within hearth features (n=10) vary considerably with respect to number of fragments, weights, and density; however the variability appears patterned. Features 9 and 13 are the most dissimilar with respect to faunal concentrations; each has 2 and 7 bone fragments respectively. The faunal remains within and near Features 13 and 16 likely relate to faunal cluster F9 associated with Feature 14. The few faunal remains in Feature 18 likely relate to faunal cluster F6b associated with Feature 12 (see Chapter 6).

Mann-Whitney U tests were conducted on faunal data with processing hearths and other hearths as the independent variable, and number of fragments, total weight, mean weight/fragment, fragment density, weight density, median maximum dimension (per provenience unit), median weight, and %burned weight. Of these variables, processing hearths had significantly higher number of fragments, weight densities, and %burned weights than other hearths ($U \leq 1$, $p < 0.05$). Other variables showed no significant differences, including fragment density and total weight, therefore, weight alone cannot be seen as the primary variable driving the other differences. A series of scatterplots are used to explore the differences between these feature types below.

More robust t-tests were conducted on the same variables in order to examine patterning among the features. These results indicated significant differences in more variables. Processing hearths had more fragments ($t=-3.38$, $p=0.01$), higher total weights ($t=-3.81$, $p=0.00$), smaller median maximum dimensions ($t=-2.79$, $p=0.02$), higher fragment densities ($t=-3.52$, $p=0.01$), higher weight densities ($t=-5$, $p=0.00$), more unidentified faunal shape ($t=-3.56$, $p=0.01$), less long bone ($p=-3.6$, $p=0.01$), more flat bone ($t=-5.12$, $p=0.00$), and greater %burned weight ($t=-2.53$, $p=0.03$). These patterns are consistent with expectations of use as processing features to reduce bone in order to extract marrow and perhaps bone grease. The lesser percentages of long bones simply reflects the higher degree of unidentified faunal remains associated with the processing areas, as the entire assemblage is dominated by long bones (see Chapter 6).

A scatterplot comparing total faunal weight and total number of fragments for each hearth shows patterning relating to processing hearths vs. other hearths (Figure 9.49). Processing hearths generally have more faunal fragments and higher total weights. Feature 1 is the most divergent, with relatively higher weight but with fewer fragments; however when the articulated vertebra are removed, it falls more in line with the other processing features. Processing features shows a possible negative relationship between number of fragments and faunal weight ($r=-0.55$), i.e., the more fragments within the hearths, the less they weigh. This pattern is the opposite of the positive linear relationship ($r=0.31$) between number of fragments and total weight exhibited by other hearths and features. The negative relationship or at least weaker positive relationship between these variables for processing hearths may be due to higher degree of fragmentation relating to processing activities around the hearths.

The relationship between median weight and median maximum dimension is illustrated in Figure 9.50. Median values were used because of the strong influence of large heavy bone outliers, like the vertebrae in Feature 1. Most of the features are similar with relatively small bone fragment sizes (1-4 cm) and low weights per fragment (2-5 g). Features 13 and 15 (burnt log) have much higher median weights and maximum dimension, further supporting the hypothesis that Feature 13 was not used in faunal processing, and the few associated fauna were fortuitously deposited there from the processing area centered around Feature 14. The similarities in weight and dimension for the other hearths suggests that relatively similar processing events took place with respect to bone breakage and resultant fragment sizes and weights. A clear positive relationship is exhibited between these two variables, as expected given relationship between size and weight, and no significant differences are found between hearth types on the basis of median weight or median maximum dimension ($U=8$, $p= 0.39$). This suggests that the size of the fragments within the different hearth types are generally not dissimilar, and only in the context of relative density and burning can differences be identified. Alternately, a closer inspection of data values for maximum and minimum dimensions may reveal more patterning than measures of central tendency. Both avenues are explored below.

The relationship between fragment density (number of fragments/m^2) and %burned faunal weight is illustrated in Figure 9.51. A clearly positive relationship can be seen, especially when removing the vertebrae from Feature 1 ($r=0.94$). Therefore, fragmentation and burning apparently are related in these features. The averages of processing hearths are much higher than those of other hearths, for both density and %burn weight, suggesting that processing activities (resulting in fragmentation) and burning were related in some fashion.

In order to examine differences in fragmentation, maximum and minimum dimension (per provenience unit) are illustrated in a series of scatterplots grouped by feature type (Figure 9.52). The differences between processing hearths and other hearths is quite clear on the basis of these scatterplots; the processing hearths are characterized by numerous small fragments (<5 cm by 1 cm), whereas the other hearths have relatively few fragments in this range. Furthermore, the near absence of faunal remains in Features 9 and 13 are apparent. Features 16 and 18 appear to have larger fragments that may have fortuitously become incorporated in the feature matrices. The processing hearths do exhibit some internal variability. Features 1 and 14 appear similar with a few large fragments and numerous small fragments. Features 3 and 5 appear similar in the absence of larger specimens (>10 cm by 1 cm). Features 10 and 12 are similar in a larger amount

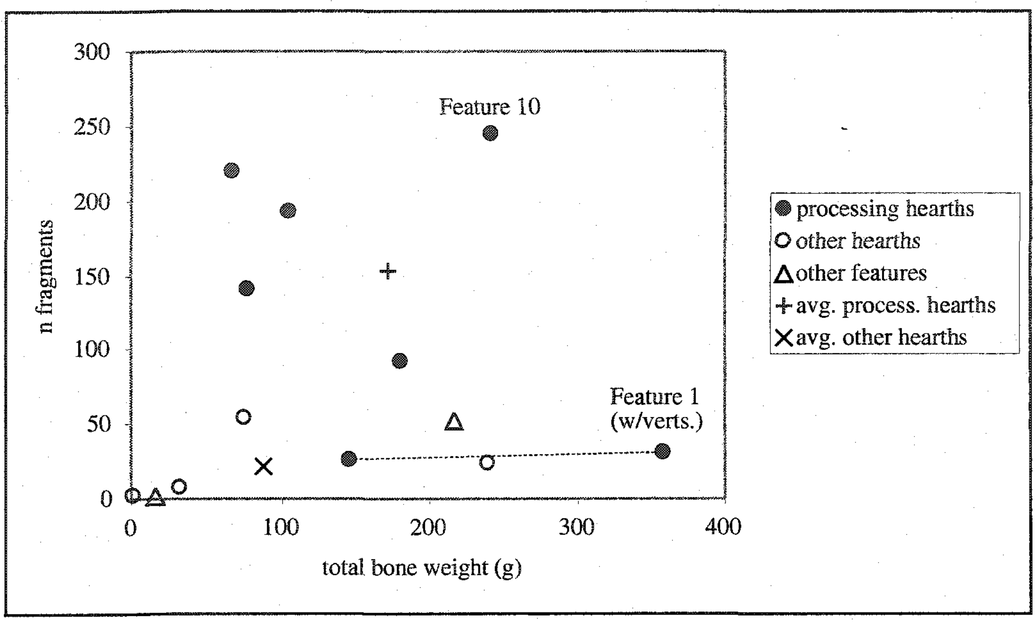


Figure 9.49 Total bone weight by number of fragments per feature.

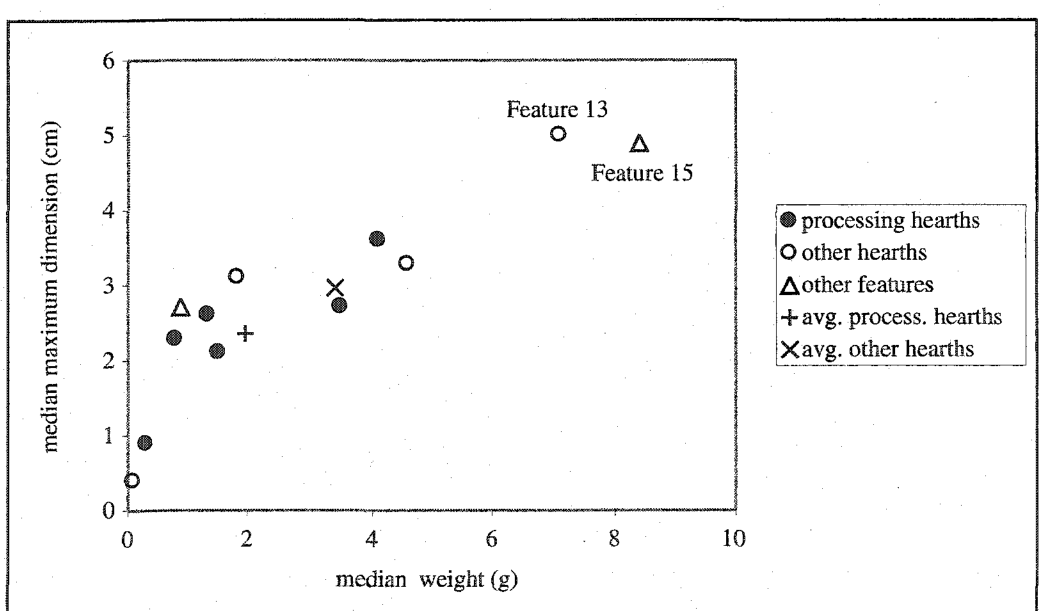


Figure 9.50 Median weight by median maximum dimension per feature.

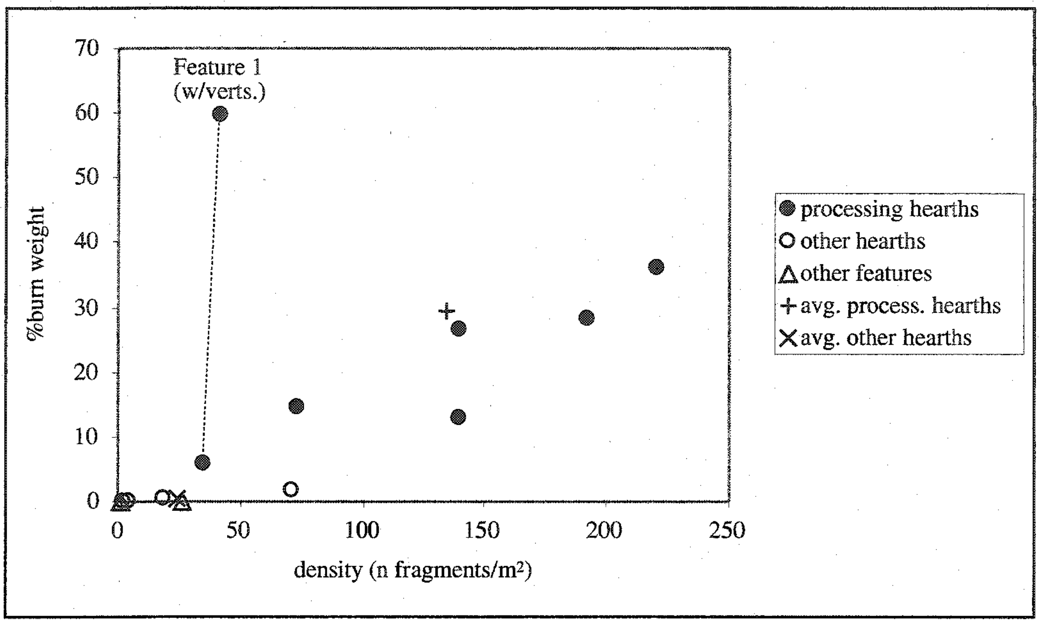


Figure 9.51 Fragment density by %burned weight per feature.

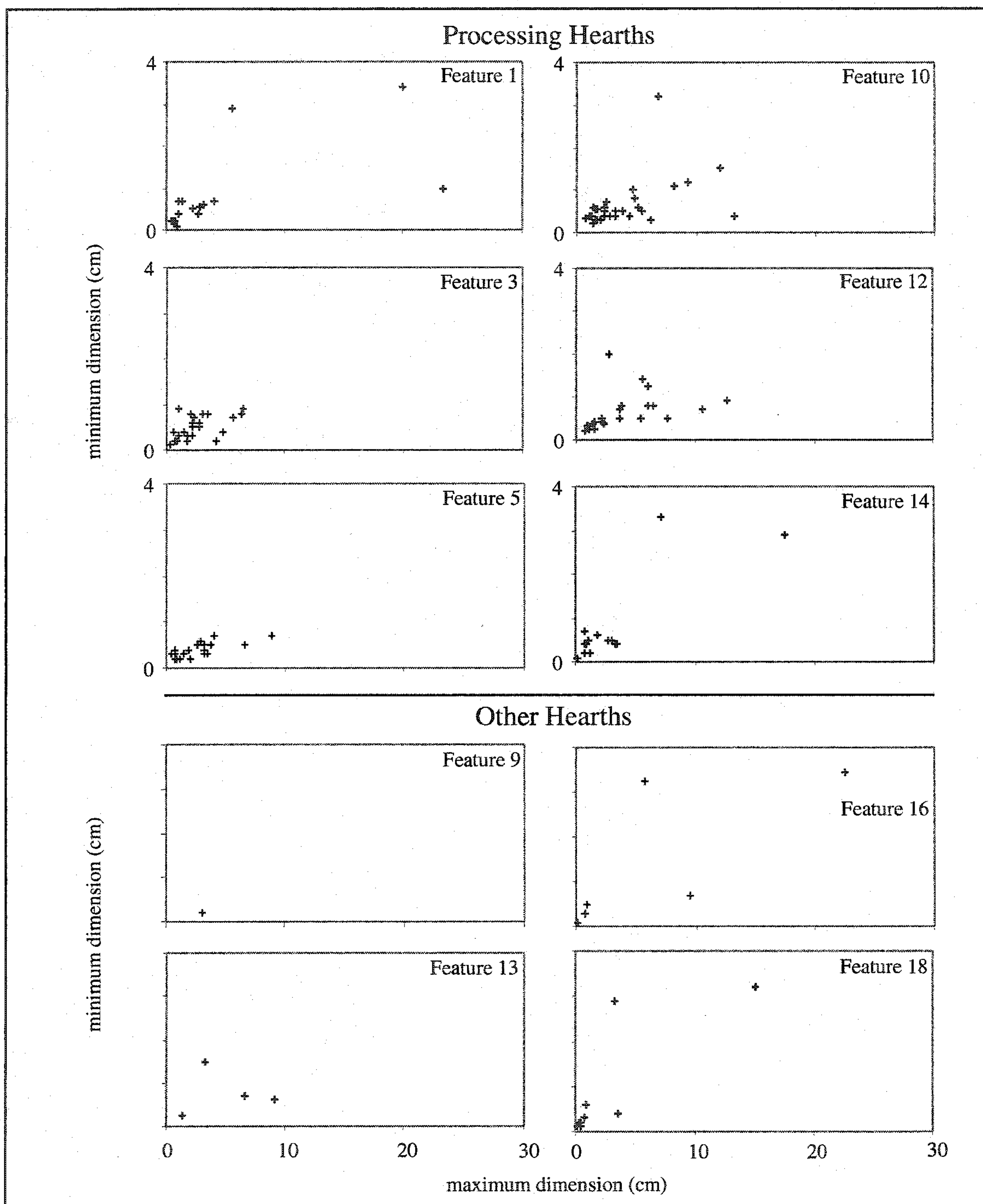


Figure 9.52 Maximum and minimum dimensions per accession and feature type.

of intermediate sized bone fragments (5-15 cm by 1-3 cm). This may relate to differences in processing activities, though the similarities in faunal shape (primarily long bones) and predominance of lower limb elements in the surrounding areas suggest overall similar processing.

In order to understand which variable is associated most strongly with number of fragments, multiple regression analysis was conducted on number of fragments (dependent variable), and total weight, maximum dimension, burned weight, and calcined weight (independent variables). Of these, calcined weight seemed to be related to number of bone fragments, and had the highest coefficient and lowest p value when it was the single independent variable (r^2=0.583, Coefficient=7.849, p=0.002). This means that the larger number of smaller bone fragments was related to processes relating to comminution.

Hearths with relatively high frequencies of calcined bone by weight (relative to other burned bone types) include Features 3, 14, 5, and 10 (10.1-100.0%) with the remaining hearths (Features 1, 7, 8, 12, 16, and 18) with low frequencies (0.0-0.6%). The four hearths with high calcined bone relative frequencies also have the four highest count of bone fragments as well as the lowest (with Features 7 and 18) bone fragment sizes. These patterns could either indicate more intensive processing within these four hearths or higher absolute temperatures than the other hearths.

All bone fragments found in direct association within the hearths were from large animals, generally medium to large mammal in size. No bird or fish bones were found associated with the features in the field or in the laboratory. The flotation samples also revealed no bird or fish bone. Identifiable bone fragments are from either *Cervus elaphus* or *Bison priscus* (see Chapter 6).

In sum, patterns derived from the faunal remains found directly associated with the hearths allow for the following hypotheses. Two of the hearths were clearly different in having very few, largely unburned faunal remains, perhaps relating to faunal processing occurring adjacent to the hearth area. These two hearths (Features 9 and 13) may have had other purposes besides cooking or other faunal-processing related tasks. The remaining hearths exhibit some variability with respect to associated faunal remains. Quantities of burned bone were found in Features 1, 3, 5, 10, 8, and 12 (and Feature 7 from Component 4) suggesting that these features may have been used in the course of faunal processing. Comparing calcined weight to other burned bone weights, Features 5, 10, and 14 had relatively more associated calcined bone, suggesting that these hearths may have been used in more extensive or intensive processing, or higher temperatures. Alternately, these features may have had bone added as a fuel source (however, see Chapter 6).

Associated floral taxa

Various macrofossil remains are another data source for understanding hearth use at Gerstle River. Six hearths produced identifiable plant taxa. All four features that underwent flotation yielded identifiable taxa (Gelvin-Reymiller 2004). In addition, three ^{14}C samples from Features 12, 13, and 14 were identifiable to genus. Table 9.4 lists each hearth and associated specimens for all macrofossil analyses to date.

Table 9.4 Component 3 features and associated flora taxa.[3]

Feature	Taxa
5	12 *Vaccinium vitis-idaea* seeds
10	4 *Vaccinium vitis-idaea* seeds, 3 *Betula* sp. fruits, 1 *Rubus idaeus* seed, 1 possible graminoid seed, 3 bud tips
12	2 *Salix* sp. twigs, 29 bud tips or complete buds
13	1 *Alnus* sp. twig
14	2 *Salix* sp. fragments (charcoal), 1 *Chenopodium album* seed, 4 bud tips, 1 possible graminoid seed, possible leaf structures.
16	1 *Vaccinium vitis-idaea* berry

The presence of fragile plant parts further supports the excellent preservation within Component 3. The most commonly recovered specimen, *Vaccinium vitis-idaea*, is present in three major areas of the site, Area A, B, and D within three hearths. This species, commonly called lingonberry, is a low creeping dwarf shrub with edible berries, common in acidic soils (Húlten 1968:731; Johnson et al. 1995:73). The presence of a complete berry of this taxa (Figure 9.42) and the seeds found in Features 5 and 10 suggest that Component 3 occupants were selecting the berries, and these were incorporated into the site. The presence of a *Rubus idaeus* (red raspberry) seed suggests that multiple berry types were brought to the site or found nearby. *Chenopodium album* (lamb's quarters) is an early successional species that cannot tolerate shade, suggesting it may have grown locally on south facing slopes near the site. The leaves and shoots can be eaten (Johnson et al. 1995:193). The unidentified bud tips or complete buds may relate to the fuel source, and could be from *Salix* sp. or *Alnus* sp., which were used as a fuel source. Bud formation occurs in Alaska during the fall, followed by dormancy over winter and growth in the spring (Gelvin-Reymiller 2004). On the basis of the presence of numerous buds within the sampled hearths, the time period of hearth use could be during the fall or winter. The presence of the well-preserved lingonberry, which ripens in August in Alaska (Viereck and Little 1986:233), suggests that occupation occurred in the fall.

Feature Diversity and Mobility

According to Chatters (1984, cited in Chatters 1987), field camps and base camps can be demarcated on the basis of feature diversity. He argues that a narrow range of specialized tasks would be characteristic of field camps (low feature diversity) while residential camps would have a wider range of more generalized tasks (high feature diversity). Features described by Chatters (1987:342) include cooking and heating hearths, earth ovens, drying racks, resource processing debris, houses, and caches. Unfortunately, this dichotomy is difficult to demonstrate in Interior Alaska given the generally narrow range of features described in the record, namely lithic scatters, faunal scatters, and hearths. There is little in the character of the features, faunal remains (Chapter 6), lithic clusters (Chapters 7, 9, 10), or spatial distributions that would suggest a residential base camp. The limited variety of features suggests a temporary field camp for Components 2, 3, and 4, and perhaps limited work stations or processing areas for Components 1 and 5.

Feature Use Scenarios

Given the data presented above, it is suggested here that the hearths within Component 3 probably functioned in a similar manner. The hearths were likely used during a relatively short duration and were used in conjunction with butchery of wapiti and/or bison that were recently dispatched near the site (see Chapter 6). The presence of numerous hearths within Component 3 could indicate either (a) that a number of sequential processing events took place over the course

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[3] Note that only four features underwent flotation (Features 5, 10, 12, and 14); the other features likely contain identifiable macrofossils.

of time, or (b) that a number of egalitarian social units were present during the processing of a larger number of wapiti and bison.

The spatial distribution of burned and calcined bone (Chapter 6) suggests that processing events co-occurred with Features 1, 3, 5, 10, 12, and 14 within Component 3 and Feature 7 within Component 4. Features 9, 13, 16, and 18 do not appear to be associated with processing events, and may have functioned as heating and lighting sources for tool maintenance and microblade production. It is interesting that these latter features all appear in close proximity to another hearth that is associated with burned faunal remains. This could indicate different hearths were used for lithic maintenance and faunal processing if they were constructed and used at the same time. The radiocarbon dating analysis (Chapter 5) shows that Features 9 and 5 are contemporaneous, Features 13, 16 and 14 are contemporaneous, however Feature 18 does not appear to be contemporaneous with Feature 12. Hearth basin morphology indicates outdoor hearths, and no lining or other features indicative of more intensive or long-term use was observed. Outdoor hearths would be more likely to be modified by trampling or other activity-related disturbance in absence of a clearly defined spatial organization that might be expected within a tent or other structure. The fact that the Component 3 hearths did not exhibit these disturbances suggests that they were contemporaneous.

Other than presence of burned faunal remains, no other evidence of substantially different functions for the hearths was discovered. The homogeneity of size and morphology suggest that none of these hearths were used as a focal hearth, acting as a central place within the site during the occupation(s). The hearths may have been used for other tasks than those relating to processing game such as heating and lighting. However, heat treatment of lithic materials does not appear to be reflected in the Component 3 assemblage. The occurrence of crazing and pot-lidding in lithic materials with Feature 2 (Component 2) could suggest heat treatment, though the majority of the associated materials (Area E) were not heat-altered. The presence of red raspberry and lingonberry plant parts suggests that floral foods were consumed near the hearths or were perhaps dried for future use. However, given the paucity of floral remains, a hypothesis of intensive floral food utilization does not appear to be supported.

Chapter 10. Spatial Analysis and Site Structure

Introduction

Site structural analysis can be thought of in terms of two problems, iterated by Binford (1983b:231-234), (1) pattern identification/recognition and (2) identification of causal relationships between the observed patterns and behaviors responsible for these patterns, through organizational properties. This chapter uses expectations derived from contextual and spatial analysis of artifacts, faunal remains, and features to assess organizational properties and interpret the spatial and technological organization of Gerstle River components.

Numerous interpretive schemas have been used to describe and explain hunter-gatherer site structure (e.g., Binford 1978b, 1980, 1983a, 1991; Stevenson 1985, 1991; Chatters 1987; Carr 1991; Enloe et al. 1994; Kent 1987, 1991; Yellen 1977a). A standard approach is where cultural relationships are inferred from diagnostic artifact types within a generalized cultural historical framework. In this approach, however, each cultural historical framework was in fact derived from single sites. In the case of Alaskan Interior archaeology, there is considerable disagreement and ambiguity in the proposed cultural historical frameworks (Cook and McKennan 1970; Dixon 1985; Bacon 1987; West 1996; Maschner 1997; Holmes 2001). Recent examples include the analysis of Campus (Pearson and Powers 2001) and Moose Creek (Pearson 1999a). Another approach is where each spatial concentration of cultural material is analyzed as a self-contained activity area. An example of this approach is the analysis of Dry Creek by Hoffecker (1983a, 1983b). Contemporaneity should be established from independent classes of data, but is generally assumed. Another problem with this approach is that archaeologists lack contextual information about prehistoric toolkits and artifact function in this region.

The general approach taken to analyze the Gerstle River data is a variant of the latter, where hypotheses of contemporaneity are tested using various classes of data, including artifact concentrations, features, and faunal remains. This type of approach requires detailed spatial analyses. In order to make the process of analysis and interpretation transparent, detailed information is presented at each stage of spatial analysis. The goal is not explication of specific patterns, that would require detailed experimental work, but rather pattern identification and exploration, in essence, how technological, faunal, and feature-related variables interact in space.

Spatial organization is the key component of site structure, and in this chapter is combined with faunal analyses (Chapter 6), artifact technology (Chapter 7), technological organization (Chapter 8), and archaeological features (Chapter 9). Similar approaches have been used for analyses of high resolution Upper Paleolithic sites, such as Verberie and Pincevent (Audouze and Enloe 1997; Enloe 1983; Leroi-Gourhan and Brezillon 1966). Carr (1991:229-230) contrasts the largely abductive contextual approach of Leroi-Gourhan and Brézillon (1966) favorably against Binford's (1978b) model-based deductive approach in the interpretation of Pincevent. The former analysis is a form of exploratory data analysis that utilized a broad range of variable classes in a form of exploratory data analysis whereas the latter analysis utilized a narrower range of data (see also Carr 1985).

The methods used to explore spatial patterning at Gerstle River are made explicit in the hopes of allowing for comparisons with components from other sites in future studies. The strength of inferences lie in linking multiple lines of evidence. The specific approach taken in this study is to produce a set of hierarchical (or nested), spatially defined, aggregate units in order to identify and explore site structure and potential activity-related phenomenon. Aggregation in this context is critical; and I have attempted to partition these data in such a way that inferences can be drawn for various levels of spatial aggregation. As the highest resolved spatial unit is derived from material type distributions of very small debitage, that are unlikely to have been curated or moved from their point of discard, inferences regarding tool use, faunal processing, and activities are in some sense independent of the data used to form the clusters. Given the distinct spatial clustering at all components except for Component 1, all could be divided into the spatial units (see below). The aggregate units used in this chapter are, from most inclusive to least inclusive: site-level (n=1), locus-level (n=2), component-level (n=5), area-level (n=10), subarea-level (n=17), and cluster-level (n=63). Each level is discussed below.

Research Objectives

General research objectives of spatial analysis include characterization of overall spatial patterning, recognition of patterned variation in depositional sets, and development of hypotheses that may explain the variation. The interaction of three main problem domains is examined in this chapter: (1) technological organization and tool use, (2) spatial relationships among features, lithics, and fauna, and (3) post occupational and post-depositional disturbance.

Potential reuse or reoccupation within Component 3 is an important problem, and expectations consistent with reuse are examined with respect to spatial patterning. The results of the spatial analyses can be integrated into a model of site structure that can be compared with current interpretations of tool use and site use in Interior Alaska. A number of critical site structural questions remain unexplored in Interior Alaskan archaeology. These questions are elaborated below.

One focus is the identification of spatial patterns of lithic tools and debitage representing depositional sets. Can depositional sets be related to possible activity sets? Are use areas internally homogeneous or heterogeneous in artifact density and composition? If so, how can the different areas be characterized? Are there recurrent clustering of tools or debitage types that may reflect toolkits or toolkit use? Are the tool clusters monothetic or polythetic (representing one or multiple modes of use)? Are the borders of activity areas sharp or diffuse? Are artifact classes constrained by their proximity to features, faunal clusters, or types of faunal clusters? Are the hearths similar or different with respect to size, morphology, and relationship to lithic and faunal concentrations, and can one or more focal hearths be inferred? What are the spatial relationships among hearths, and how can they be interpreted? Are the artifacts within each functional type random or clustered? If the artifacts are clustered, how do the spatial distributions relate to depositional and activity sets and variation across each component? Were the depositional sets produced through expedient or formal technologies?

The resulting models of site structure for each component contain various elements including number of flaking episodes, associated hearths, inferred wind direction, associated faunal clusters, seating models, variations in microblade use, and inferred activities. These models are used to address issues of dimensional organization of space in Chapter 11.

Methods

Assumptions and Expectations

While no behavioral assumptions are made for the description of the spatial patterning, the Activity Model (Binford 1983b) is used as a basis for interpretation. The relevant statement by Binford and Binford's (1966:291) is as follows:

> The basic assumption allowing us to deal rationally with archeological assemblages is: The form and composition of assemblages recovered from geologically undisturbed context are directly related to the form and composition of human activities at a given location.

This is an important point that has sometimes been taken to mean that recurring sets of artifacts represent functional toolkits (e.g., Schiffer 1976). Binford (1983b:69, footnote 2) later clarified this statement, noting "a cultural system was internally differentiated and that there were regular and repetitive organized units of things within the system." I fully realize that the location of an artifact within an archaeological site does not necessarily correlate with its last utilization. However, the location is related to deposition (controlling for post-depositional disturbance factors), and patterning among feature, lithic, and fauna locations at Gerstle River may offer an avenue into site structure and organization. Following Binford, who advocates identifying ambiguity, the research presented in this chapter utilizes a number of different classes of data in order to document patterning and offer explanatory hypotheses consistent with the data. It is beyond the scope of this dissertation to definitively link observed spatial patterns with ethnographic examples by way of analogy. Given our lack of understanding of organizational properties of early prehistoric Interior Alaskan populations, such an approach is not only premature, but also would be an abuse of ethnographic analogy (see Binford 1987:453). Instead, plausible scenarios are offered here that may explain the observed patterns; but they are given as hypotheses to be tested with further independent data. The strength of this approach is in using context to situate the variables and to independently assess expectations generated by certain hypotheses.

All things being equal, variability in assemblage and intrasite structure and organization should be related to activities occurring on the site, and spatial concentrations of artifacts should be related to activities that occurred there (Binford 1978b:357). It is understood that numerous factors can distort the relationships among activity sets and depositional sets (see Schiffer 1976). While this assumption may not be tenable for habitation sites or sites with evidence for post-occupational or post-depositional disturbance, the nature of the Component 2, 3, and 4 assemblages suggest it may be applied. The vast majority of lithic items are unmodified and are very small, therefore it is unlikely that they do not at least partially reflect activities occurring during their depositional. The nature and context of the lithic and faunal remains and features suggest a short-term camp. No middens or formal storage areas (pits, caches), indicative of longer-term habitation are present. The hearth feature do not overlap, and they are relatively thin.

The lithic concentrations show relatively little lateral dispersal, and are spatially concentrated in discrete clusters suggesting individual flaking episodes. The large variety of lithic raw material types in Component 3 especially can be used to facilitate a fine-grained analysis of site use. If there were relatively few material types, such an analysis may not be feasible, and this assumption would be unwarranted.

Lithic tools recovered at each spatial unit generally reflect discard behavior (depositional sets), and may or may not be associated with activity sets that occurred at the specific spatial units. Put another way, artifacts, features, and faunal remains found together may not have been produced together, but they are in the same depositional context for analytical purposes. This spatial analysis does not assume that components were single occupations where a single task was performed, but as a sequence of events that all effect the final observed patterning. It is recognized that more than one activity may have resulted in depositional sets that are clustered together (i.e., polythetic). Several factors may affect this, including duration of occupation, number of occupants, and nature of the activities. Spatial position of artifacts may result from activities relating to its initial use and deposition, but may also include recycling and displacement.

Lithic assemblage variability among clusters may result from (a) different activities, (b) cumulative activities of a similar nature, or (c) differences in deposition. If variability is a result of different activities, one might expect to see different tool types present, or a different array of tool types. If variability is a result of an accumulation of debris from a series of similar activities, one might expect to see higher frequencies of similar tool types. Lithic items are positioned relative to hearths and not the reverse (Clarke 1977; Simek 1984). Hearths are treated as site furniture around which activities took place. This is not to say that all hearths were used for identical purposes, merely that one significant property is that they cannot be physically moved (though another hearth may be created elsewhere).

Bone dumps or fauna refuse locations should be more dispersed or scattered than concentrations at processing areas, and may be recognized by their location away from activity areas, such as lithic manufacturing or maintenance areas (see Binford 1978b, 1987).

Variables

A number of contextual variables are used to address the research questions described above. These include lithic, faunal, and feature related data along with spatial relationships among them. Faunal spatial data have been examined in Chapter 6. Lithic data include material type distributions, refitting, relationships between tools and debitage, tool diversity and abundance, tool classes, and modified microblade and flake typologies (based on analysis in Chapters 7 and 8).

• Material type distributions of debitage are important as they are very small (generally <1 cm in maximum dimension), not usable and should be expected to remain where they are deposited. Tools of the same material type can be assessed spatially and hypotheses can be made as to their relationship based on the condition and type of tool and other contextual information. Specialized reduction areas, including microblade production and non-microblade tool maintenance can be identified.

• Refitting lithic items and faunal remains may be used to address concurrent use of the site, and perhaps infer similar types of activities. If refits are located in areas relatively far apart, they may be used to infer contemporaneity.

• Number of tools and number of debitage relate to accumulation, tool manufacture, maintenance, and use. Count, weight, and various density measures can be used to compare different spatial concentrations.

• Microblade technological variability, following patterning observed in Chapters 7 and 8, are examined at various spatial levels in this chapter. Patterning that may be invisible at the level of component may be visible at higher resolution.

Spatial data include but are not limited to the following:

• The positions of tools and debitage and bone relative to each other may indicate recurrent patterns of deposition.

• The degree and nature of spatial overlap of debris scatters may be used to infer contemporaneity, reuse, or sequential use of areas.

• Void spaces that are empty of cultural debris. These may demarcate sleeping areas or activities that necessitated a clean area (such as drying racks).

• Arcs of debris are identified by sharp borders of cultural material. These can be positive (presence of material defined by a sharp boundary) or negative (absence of material defined by a sharp boundary). This pattern may indicate where debris was removed (in the case of negative arcs of debris) or fell (in the case of positive arcs).

• Density of debris around the hearth features. This may affect movement and constrain activities around the hearths.

• Orientation of large items such as boulders, that are less likely to be casually displaced.

• Articulated faunal remains may indicate that they were not as disturbed as more fragmented faunal remains.

• Hearth stratigraphy strongly suggests single use events. Gerstle River hearths have a single oxidized lens indicative of single use periods

• Inter-hearth spacing can be used to infer contemporaneity. Gamble (1986:258-263) suggests that a three-meter regularity may equate to multi-user outdoor hearths. While this relationship is tentative, a more clustered arrangement of hearths may indicate reuse of the area by later occupations.

Analytical Methods

The process of aggregation employed in this study is iterative. The lowest level, with the highest resolution, is based solely on material type distribution and spatial location. The distribution of debitage concentrations is the fundamental unit and the basis for all subsequent lithic spatial aggregation. Debitage concentrations offer important insights on spatial organization because of a number of factors. First, debitage in the form of small fragments are not likely to have been removed and used as blanks for further tools. They are the least mobile portion of lithic assemblages, in the sense that small fragments likely remain where they were struck. They are easily embedded in the matrix, and for short term camps like those at Gerstle River, there is less likelihood for sweeping or clearing away debris around living areas. Such remains would likely be missed in such a sweeping or clearing operation. Debitage can be used to reconstruct activity areas more conformably than discarded tools that may have been tossed away after the last use. The tools at Gerstle River, especially the formal tools, are highly curated, and are not likely to be discarded at their place of manufacture, or possibly at the place of their last use. However, patterned discard distributions, when used in conjunction with other tools, debitage, and fauna, may be illustrative of organizational properties at the site.

The spatial patterning of the debitage cluster level was evaluated based on two datasets. The first was point clouds derived from three pointed lithic items by material type and component. This was done in order to provide the highest level of resolution afforded by the data, as even screen data from 0.25 m^2 quads may result in a lower signal to noise ratio in the spatial distribution of artifacts. As shown in Chapter 2 (Table 2.1), 40% of all lithic items had three-pointed provenience. For lithic items above 1 cm in diameter (n=1623), 63% had three-pointed provenience. For lithic items above 2 cm in diameter (n=398), 83% had three-pointed provenience. Thus, the point clouds provide excellent resolution in delineating lithic concentrations.

The second dataset was density isopleths based on all lithic data provenienced in 0.25 m^2 quads (99% of total lithic items). The remaining 1% provenienced to larger areas (generally 1 m^2), were assigned to a specific quadrant based on observed densities. Database files consisting of all flakes and/or microblades by material type (x=east, y=north, z=number of flakes and/or microblades) were constructed to encompass 50 cm square quadrants. Thus, for one excavation unit (e.g., N40E50), four data points were derived from combined data from 3-pointed and screened artifacts (e.g., N40.25-E50.25, N40.75-E50.25, N40.25-E50.75, and N40.75-E50.75). These files were used to create grid files in Surfer ™ application. Grid files were delimited by the limits of excavation. The quads outside of the excavated areas were not given z values. As absence of lithic material is as important as presence, z values of 0 were given in all quads within the excavation area where no flakes were recovered. This is important for an accurate representation of the debitage clusters since extrapolation of debitage beyond the excavated areas may result in inaccurate distribution (contour) maps. Kriging with the default linear variogram was the gridding method used, given its flexibility and general utility.

These grid files were used to generate contour maps by interpolation between the given z values. The contours were smoothed within the existing grid files. A number of level parameters were used, including arithmetic (every 1, 5, 10, or 20 items/0.25 m^2), and geometric (1, 2, 4, 8, 16, 32, ... items/0.25 m^2) sequences. Figure 10.1 compares an arithmetic interval of 20 items/0.25 m^2 and a geometric interval of 1, 2, 4, 8, etc. The arithmetic interval shows very discrete and abrupt boundaries of lithic clusters and subareas. Of these interval types, the geometric series was used because it displayed smaller clusters that would otherwise be missed at higher intervals, and limited the dense contours for denser clusters. The use of geometric intervals inflates the appearance of low density areas between concentrations. The contour maps were exported as

AutoCAD ™ .dxf files that were imported into Macromedia Freehand ™ base maps as vector graphics along with other data. Density maps were produced for each material type (with totals greater than 20 items) within each component (see below).

The point clouds were compared with the density isopleth contours from the 0.25 m^2 quads, and the resulting congruence was generally quite highly resolved (see Figures 10.2-10.20). Lithic clusters were divided on the basis of presence or absence of microblades, and variations in microblade technology were examined at that level, primarily with respect to number, segmentation distribution, modification percent, and modification type. Microblade cluster groups were formed from patterning of these variables, and these were tested against each other for significant differences in other variables, including proximal width. The results are interpreted in relation to various microblade related tasks, such as inset removal and discard, microblade production, and microblade use, and these are incorporated in subarea and area level analyses. Given the rarity of bifaces and unifaces, non-microblade clusters were analyzed for differences in debitage size distributions.

Subareas were defined on the basis of spatial distribution of lithic clusters, and are generally separated from each other by about two meters. Details of this process are provided below, and include boundary assessments. Analyses at this level relate to variation in lithic raw material use, tool distribution, including relationships to debitage clusters, spatial distribution, and co-occurrence, and variation in microblade production.

Areas were defined on the basis of spatial distribution of subareas, and are generally separated from each other by 2 to 10 meters. Details of this process are provided below. Analyses at this level relate to comparisons of subarea technological patterns, feature drop and toss zones, spatial and functional association among lithics and faunal remains. For various reasons described below, the hearths in Components 2, 3, and 4 are considered outdoor hearths. The men's outdoor hearth model, first constructed by Binford (1978b) and later developed by Stevenson (1991) and others, is used to assess spatial patterns relative to hearths. In the model used here, the drop zone is defined as 0.0-1.4 m from the hearth centroid, the toss zone is defined as 1.4-2.5 m from the hearth centroid, with an intermediate displacement zone (between 1.0 and 1.4 m from the hearth centroid). Thus, feature and faunal data are integrated at this level. Descriptions of each area and interpretation of spatial organization are given.

Components were defined on the basis of stratigraphy and radiocarbon dates (see Chapters 4 and 5). Analyses at this level relate to overall spatial and technological organization.

Three phases of site use for each component and occupation are considered following Stevenson (1985), initial (settling-in) phase, occupation/exploitation phase, and abandonment phase. While expectations of what activities may have taken place at each phase is not assumed, explicit hypotheses are formed for these activities and tested against the data.

Thus, each level of spatial organization requires different data, and relate to different analyses. Lithic clusters are used to examine use of raw materials. Subareas are used to examine microblade technological variability, refits, raw material use, tool distribution, and relationship of lithic clusters. Areas are used to examine the interrelationships of lithics, fauna, and features. Components are used to examine overall site structure, organization, and function.

A summary of spatial aggregation levels is provided in Table 10.1. More detailed descriptions of level formation are provided in the next section.

Table 10.1 Spatial aggregation levels at Gerstle River.

Spatial aggregation level	*N*	*Criteria for aggregation*
Cluster	63 35	Spatially discrete (>1 m) by material type, where n>3 items where n>30 items per material type
Subarea	17	Spatially discrete (≤ 2m) (except for separation of Subareas C2, C3, and C4)
Area	10	Spatially discrete (>2m)
Component	5	Spatially, stratigraphically, and chronologically discrete
Locus	2	Discrete in terms of topography, elevation, relief, aspect, distance
Site	1	Discrete in terms of geomorphology

Levels of Aggregation

A series of figures illustrates the development of the spatial aggregations of lithic materials. Figures 10.2, 10.4, 10.6, 10.19, and 10.20 show locations of all three pointed flakes and microblades (when present) for Components 1, 2, 3, 4, and 5 respectively. Figures 10.3, 10.5, and 10.7 show point clouds for each material type and the delineation of subareas and areas for Components 1, 2, and 3. Point clouds are shown as transparent lenses; thus the darker the overall appearance the more overlapping concentrations of different material types are present. Given the small number of material types and limited spatial extent of Components 4 and 5, point clouds are not shown for these components.

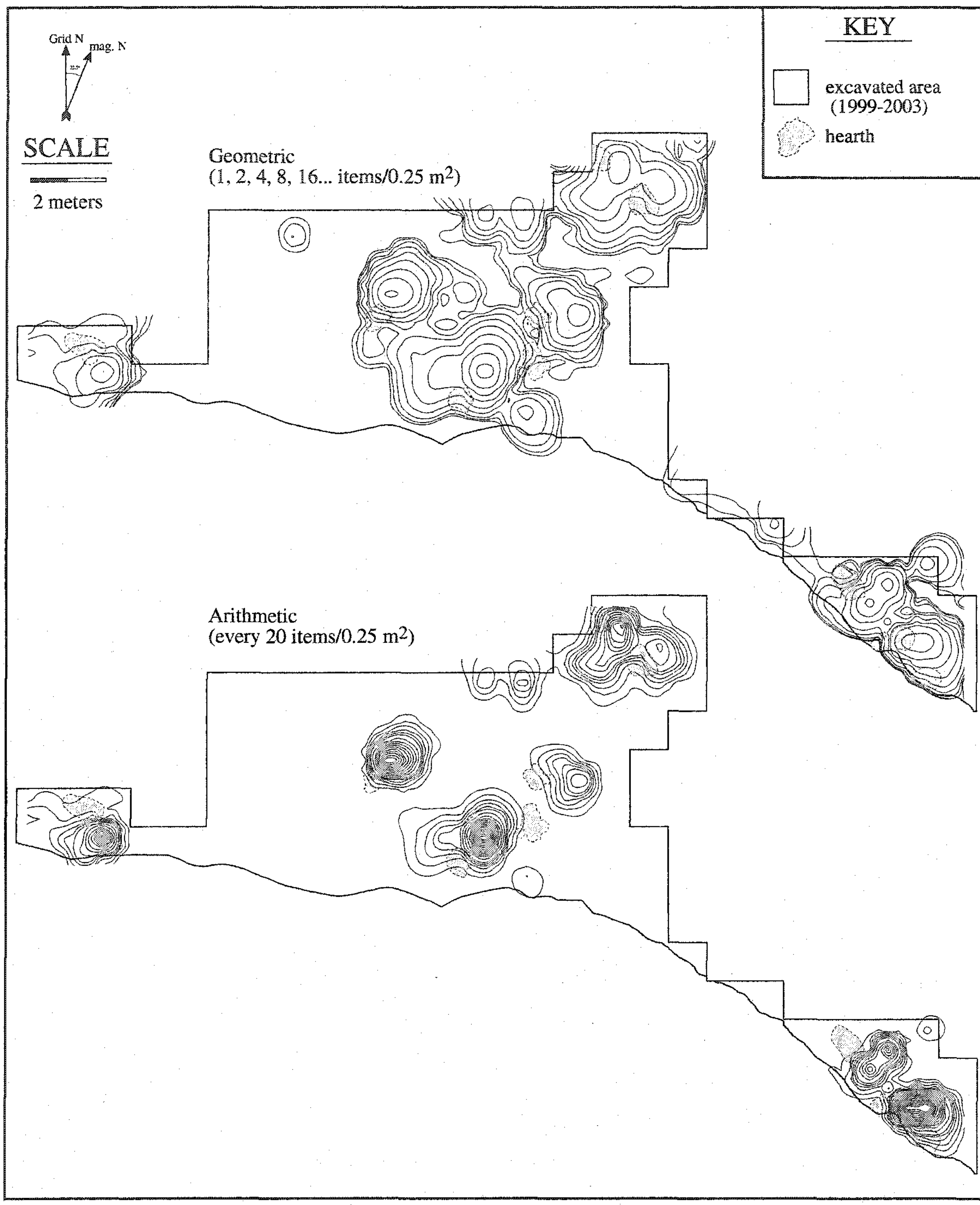


Figure 10.1 Comparison of Component 3 combined microblade and debitage isopleth contours.

Given the complexity of the Component 3 data, a series of maps are provided detailing the spatial distribution of each material type (where n>30) (Figures 10.8-10.18). The concentrations by material type are revealing in that each has a relatively limited distribution consistent in size with a single stationary knapping episode, except for gray and black chert (C1 and C4) and a few other clusters of other rmaterials. Gray chert almost certainly represents multiple materials, but given the variability within gray chert, it cannot be further distinguished without more detailed analyses (see Chapter 7). These figures should be consulted to visualize cluster locations in the analyses that follow.

Clusters

The lowest level of aggregation is the *Cluster*. Each cluster is defined by spatial separation by at least 1 m from other clusters of the same material types using the distributions (three-dimensional point clouds and density contours) of all microblades and non-microblade debitage. Tools were not included in this delineation, as they are more likely to be moved from their point of manufacture. A total of 63 clusters were identified for the five components (C1, C2, C3, C4, and C5). Most clusters are generally 1-2 m in diameter, and may correlate with flaking events. Two different agglomerations were used, Cluster 1, based on all spatially discrete clusters of each material type, where n≥3, and Cluster 2, where n>30. Each agglomeration afforded different levels of spatial resolution and statistical reliability. Each cluster may represent one or more flaking event(s) given the available spatial resolution. Clusters are labeled by area and material, and are given alphabetical suffixes if more than one discrete cluster of a certain material type is present within each area (e.g., BmC1b is the second cluster of material type C1 in Area B). Cluster, area, and subarea spatial distributions for each component are presented in Figures 10.2-10.20. Due to the complexity of material type distributions in Component 3, Figures 10.8-10.18 illustrate the spatial distributions of Component 3 clusters. These figures serve as guides for the analysis and discussion that follow. Summary data for clusters are provided in Table 10.2. Data from this table are used in the discussion of subarea level spatial analysis below. Subareas and areas beginning with A-D are from Component 3, E-F are from Component 2, G-H are from Component 4, J is from Component 5, and K is from Component 1 (see below).

There were no great impediments to cluster delineation. In all cases except for Component 1, the lithic material types formed relatively small discrete aggregates within the site. Component 1, due to the taphonomic factors that resulted in a more disturbed vertical and probably horizontal distribution, is assessed as a single cluster per material type except andesite (An), which is found in two discrete clusters (see Chapter 4 and Figure 10.8). Given the clear spatial separation of different clusters, k-means clustering was not used at this level of aggregation.

Subareas

The second level of aggregation is the *Subarea*. Each subarea is defined as a spatial concentration of lithic clusters separated from other clusters generally by ~2 m. A total of 14 subareas were identified for the five main components (one in Component 1, two in Component 2, eight in Component 3, two in Component 4, and one in Component 5). Most subareas are generally 3-4 m in diameter, and may correlate with activity areas. This level was used primarily to discriminate smaller clusters within the main areas (see below). Cultural materials within subareas may be reasonably assumed to have been deposited at the same time or nearly the same time and reuse or reoccupation may have been limited. This is based on ethnographic data showing that hunter-gatherers generally avoid camping in the refuse from earlier occupations (Yellen 1977a; Schiffer 1987). Given the absence of clearing, this assumption is considered reasonable.

Given the clear spatial separation among subareas (see Figures 10.1-10.20), k-means analysis was not used to assign cluster membership. Each of the subareas appeared to have a relatively homogeneous distribution (i.e., no obvious sub-clustering within the subareas) with the exception of the eastern portion of Area C. Area C was clearly separated into two subareas; the western group designated Subarea C1. The eastern group posed a special problem with subdivision. Though the 3-dimensional point clouds suggested three possible subunits, there are no discrete artifact gaps in the density isopleths (Figure 10.21, compare with Figure 10.1). When visually assessing the 3-point data on all lithic items in the area, possible subdivisions emerge. Given the spatial distribution of lithic artifacts in this area, three clusters of lithic material can be tentatively posited. This separation was confirmed when k-means cluster analysis was conducted (Figure 10.21). The three aggregates are defined here as Subareas C2, C3, and C4.

Table 10.2 Cluster level summary data (where n>30 items).

Cluster	N items	Flakes	Microblades[1]	Cores[2]	Tools[3]	Total weight (g)	Tools[4]
AmAr	433	235	196		2	37.88	2 MF, 21 MMB
AmC4	369	351	18			17.38	1 MMB
BmC1a	315	170	134		11	21.53	6 BS, 5 MF, 18 MMB
BmC1b	1097	859	215	7	16	102.15	1 BIF, 9 BS, 5 MF, 18 MMB, 1 SS
BmC1c	88	86	2			2.76	
BmC2a	534	534				23.97	
BmC4a	100	98	2			3.12	
BmC4b	55	54	1			1.93	1 MMB
BmC4c	79	73	5		1	3.13	1 MF, 1 MMB
BmC4d	31	25	3	3		6.47	2 MMB
BmC9	42	42				1.50	
BmCh3	130	130				4.76	
BmR2b	55	55				1.81	
CmAna	100	92	8			9.17	
CmC1	775	567	170	3	35	110.48	11 BS, 1 BU, 23 MF, 14 MMB
CmC4	67	29	29		9	15.57	9 MF, 3 MMB
CmC7a	154	109	42	3		11.54	
CmC9	50	39	11			3.68	
CmO	59	37	22			3.52	5 MMB
CmR1	353	181	170	2		20.74	9 MMB
CmR2	96	96				3.83	
DmC1a	1121	931	180	4	6	123.66	6 MF, 7 MMB
DmC4a	45	39	1	1	4	28.04	2 BS, 1 ES, 1 MF
DmC4b	116	77	36	1	2	23.69	2 ES, 2 MMB
DmR1	51	45	6			2.37	2 MMB
DmR2a	84	81			3	32.59	1 BS, 2 MF
DmR2b	378	374	2		2	32.30	2 MF
EmC1	50	9	37		4	5.57	4 BS, 3 MMB
EmCh1	368	295	64	6	3	32.80	3 BS, 6 MMB
EmCh2	42	39	3			3.44	3 MMB
FmQa1	329	329				11.79	
JmR2	39	39				1.25	
KmAna	92	92				22.21	
KmC5	1769	1764			5	116.09	2 BIF, 1 BS, 2 MF
KmQ	163	163				16.61	
TOTAL	10074	8448	1456	32	138	1030.56	

[1] Microblades include both modified and unmodified microblades.
[2] Cores include microblade cores, core fragments, core tablets, and facet rejuvenation flakes.
[3] Tools include all lithic tools except for modified microblades, boulder spall scrapers, and cobble tools.
[4] BIF = biface, BS = burin spall, BU = burin, MMB = modified microblade, MF = modified flake, ES = short axis beveled flake, SS = long axis beveled flake.

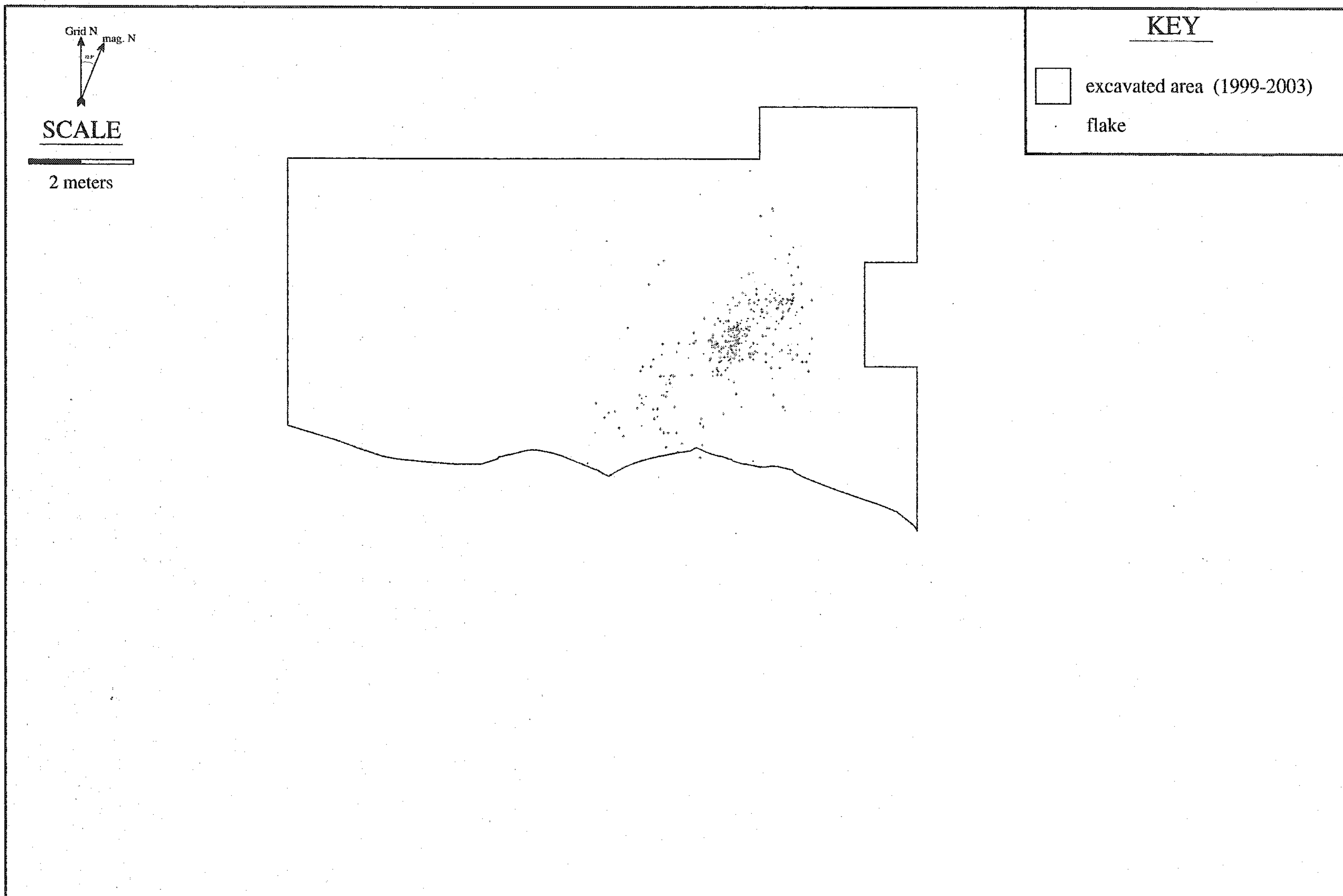


Figure 10.2 Component 1 three pointed flake distribution.

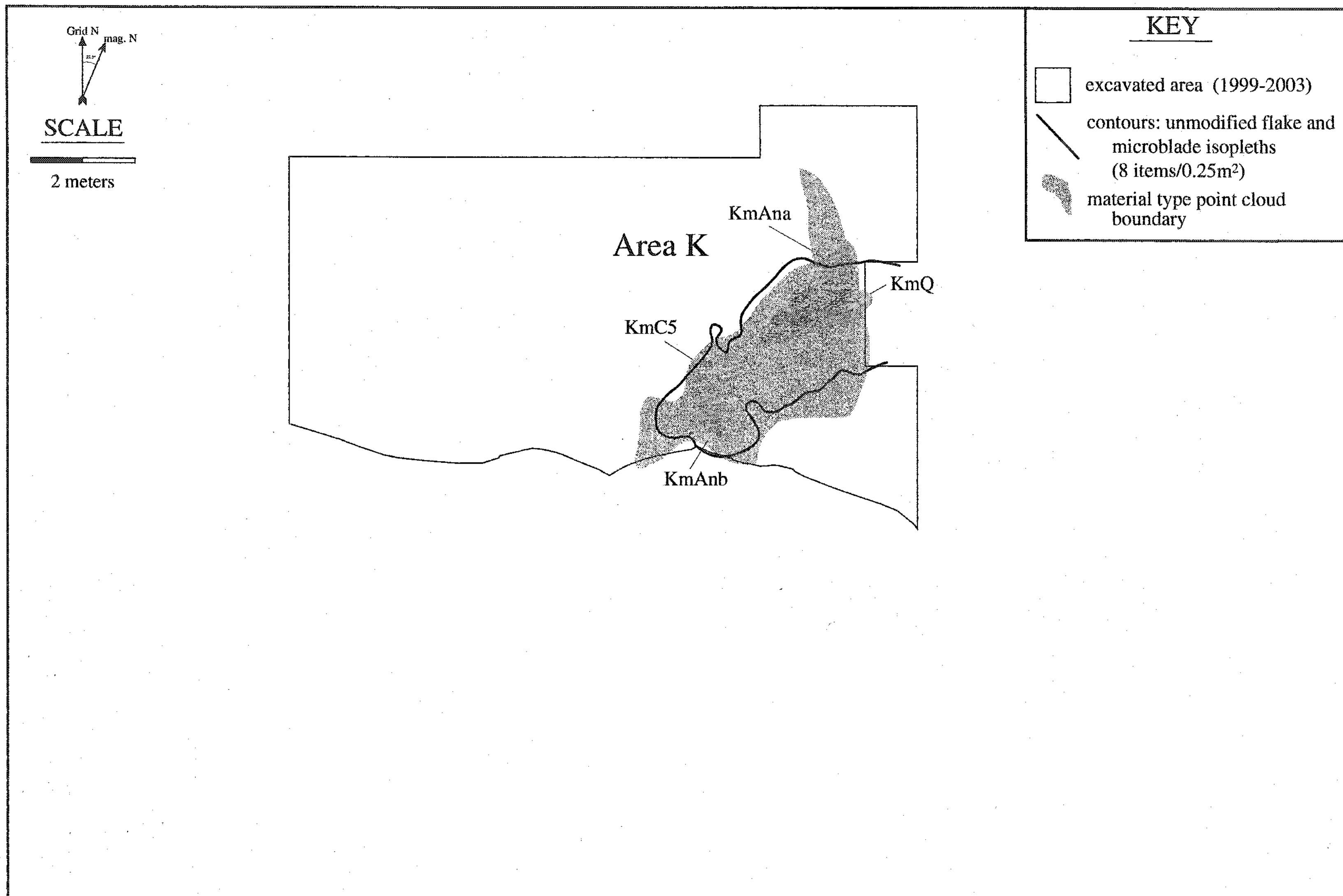


Figure 10.3 Component 1 material type point cloud (cluster) distributions and lithic area.

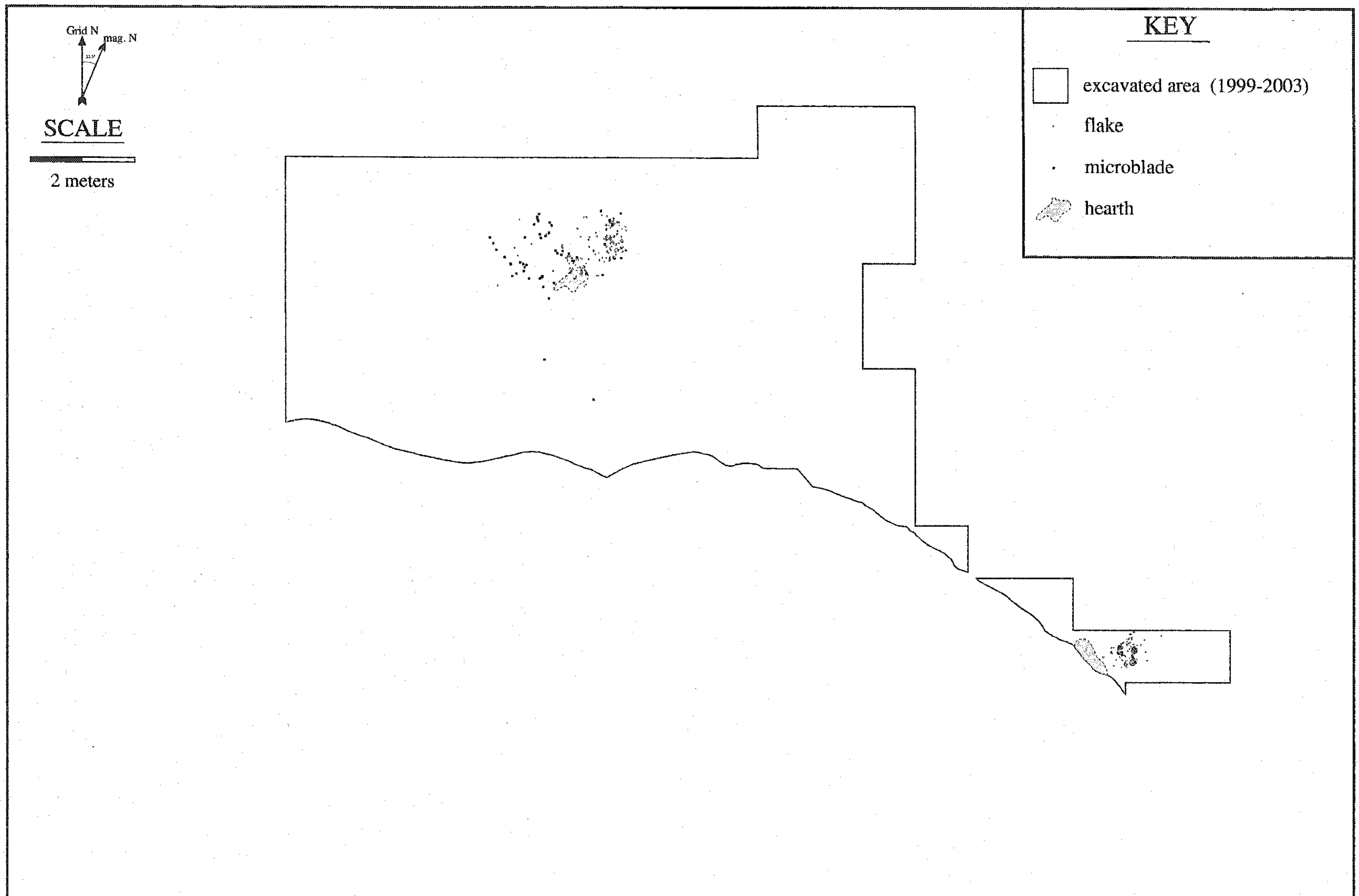


Figure 10.4 Component 2 three pointed flake and microblade distributions.

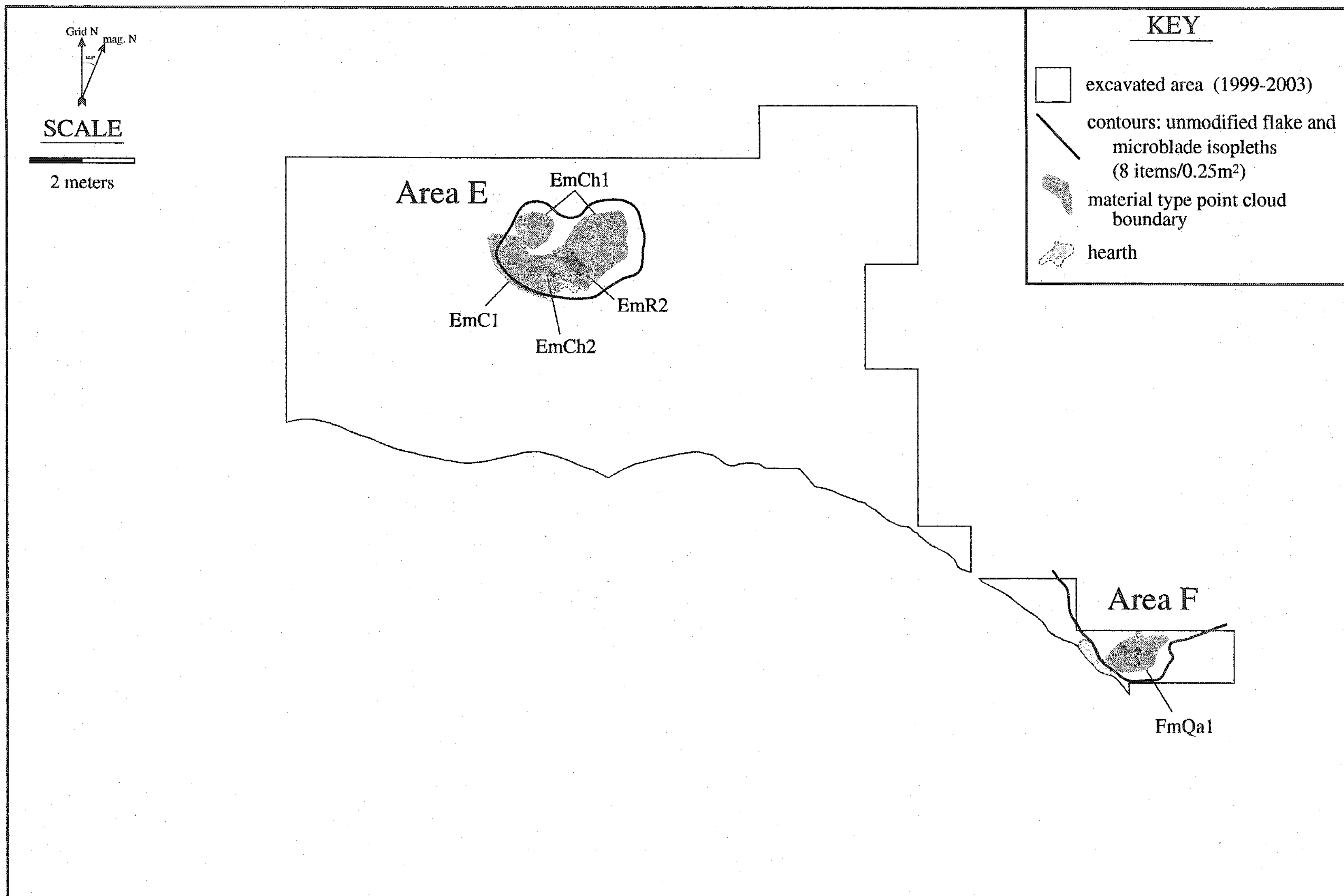


Figure 10.5 Component 2 material type point cloud (cluster) distributions and lithic areas.

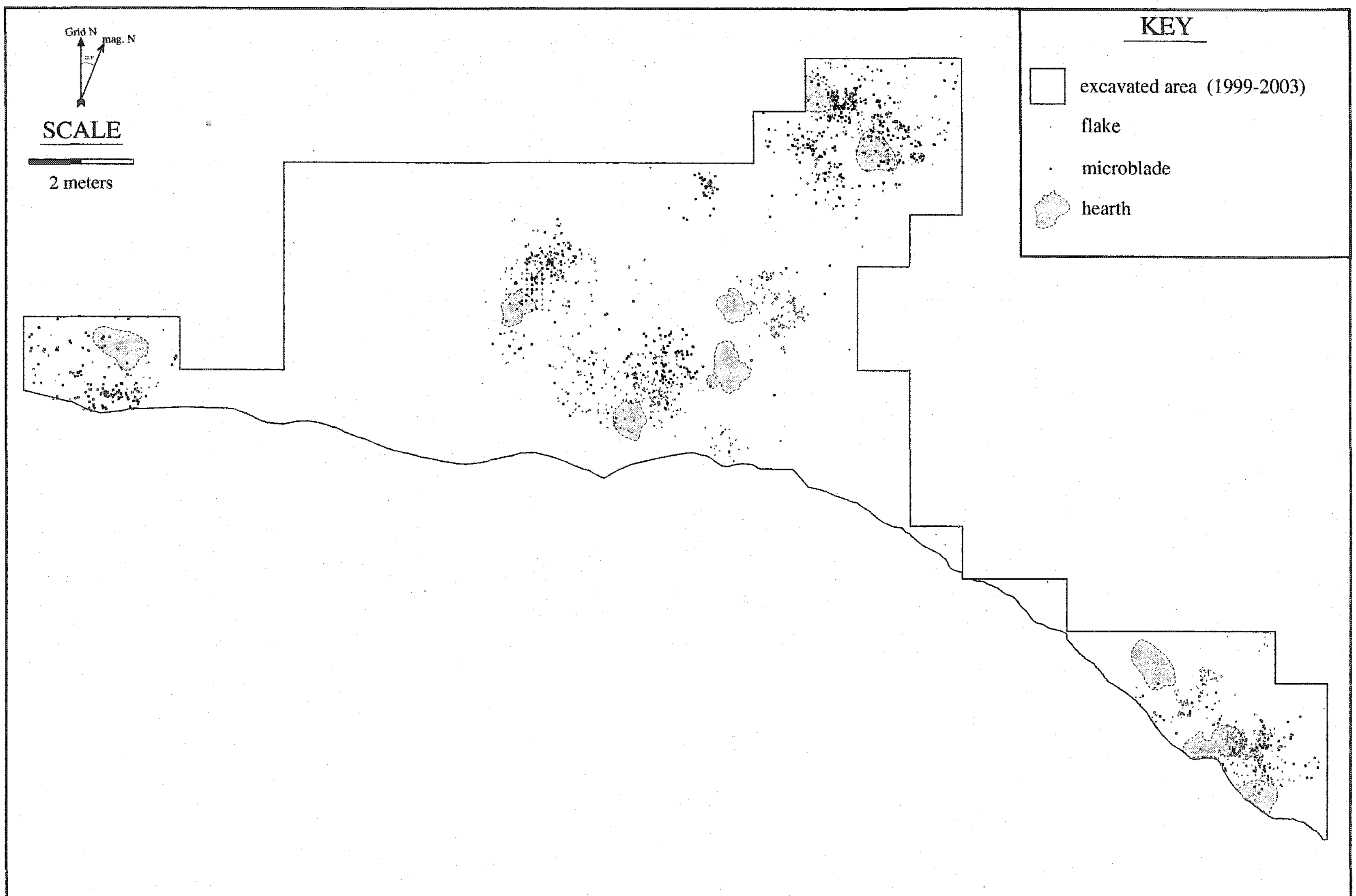


Figure 10.6 Component 3 three pointed flake and microblade distributions.

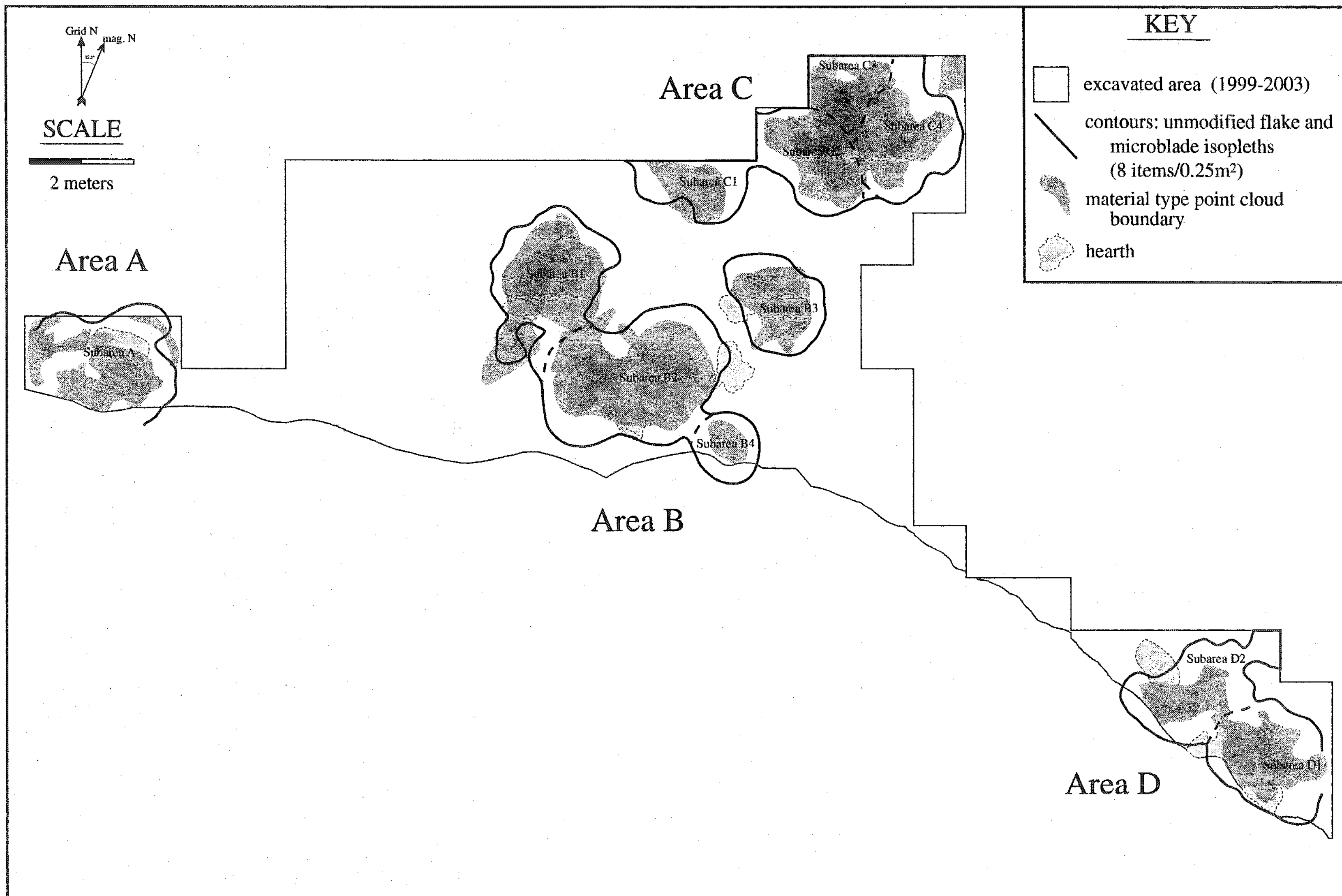


Figure 10.7 Component 3 material type point cloud (cluster) distributions and lithic areas and subareas.

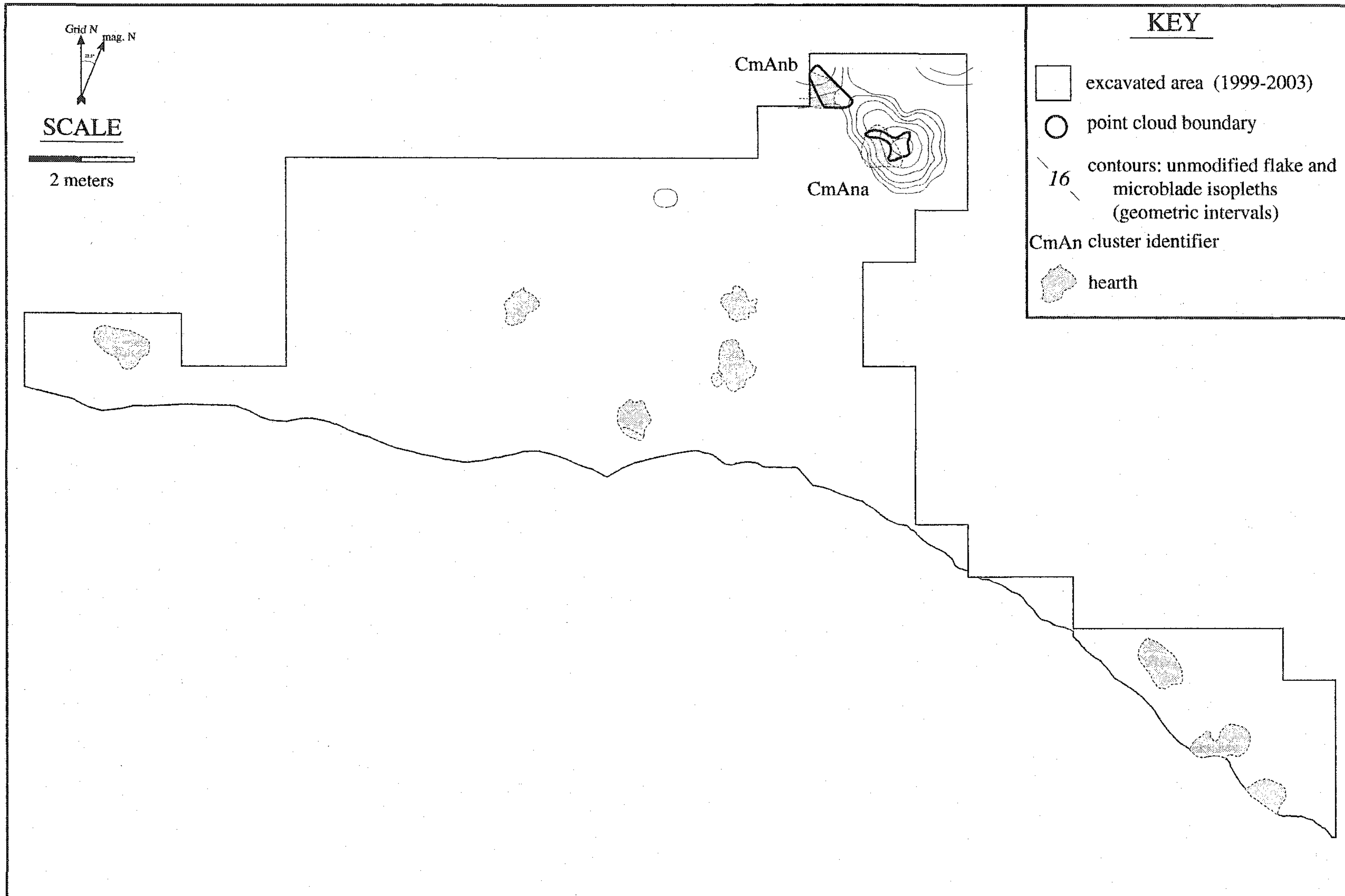


Figure 10.8 Component 3 andesite (an) distribution.

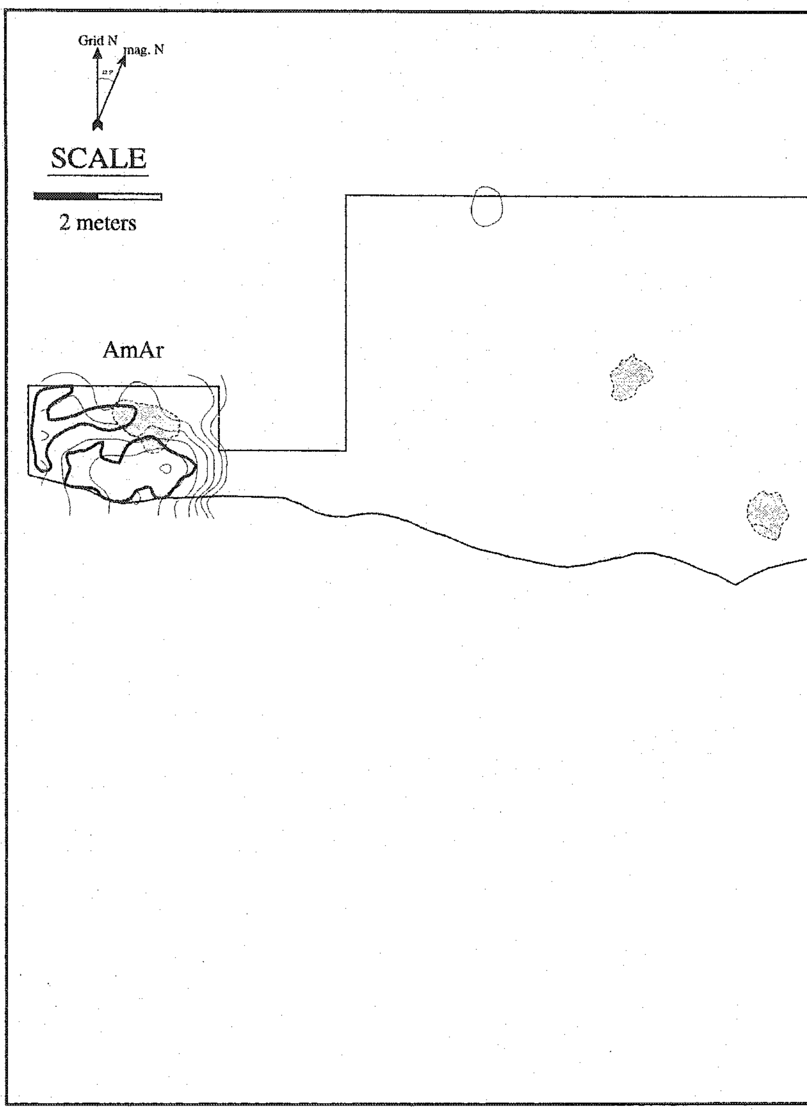
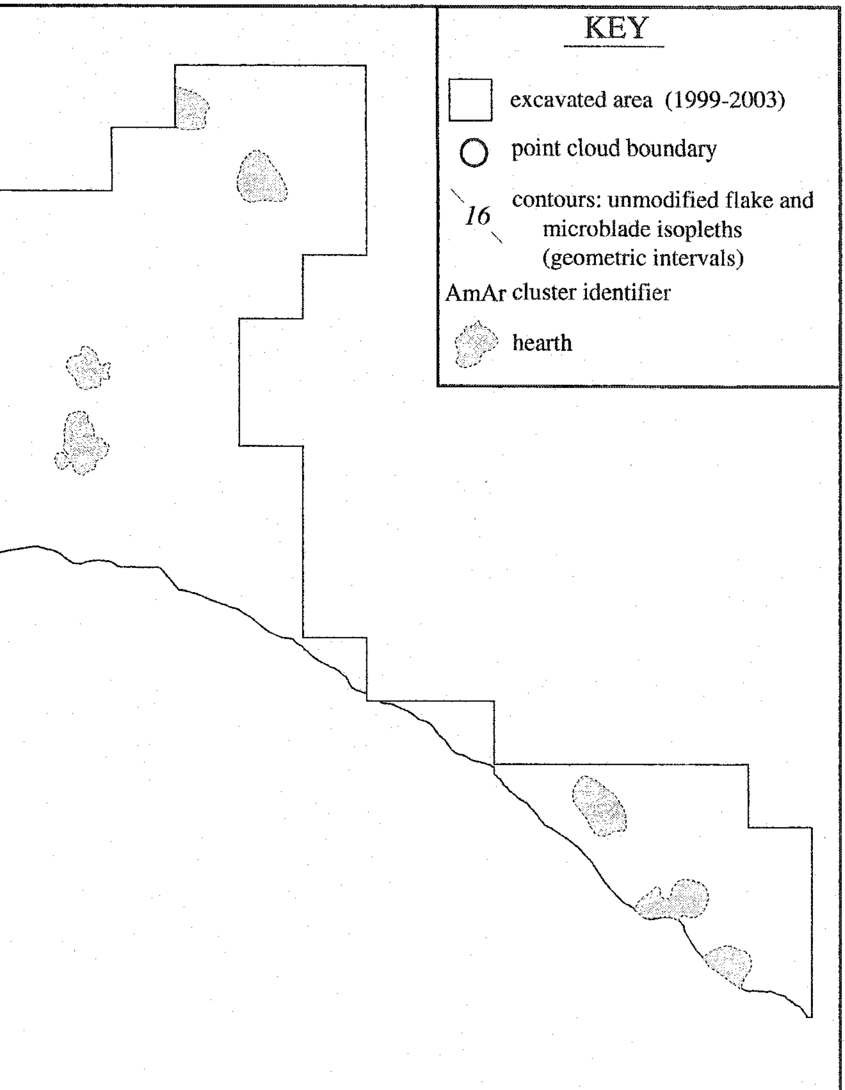


Figure 10.9 Component 3 argillite (Ar) distribution.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point cloud boundary
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AmAr cluster identifier
hearth

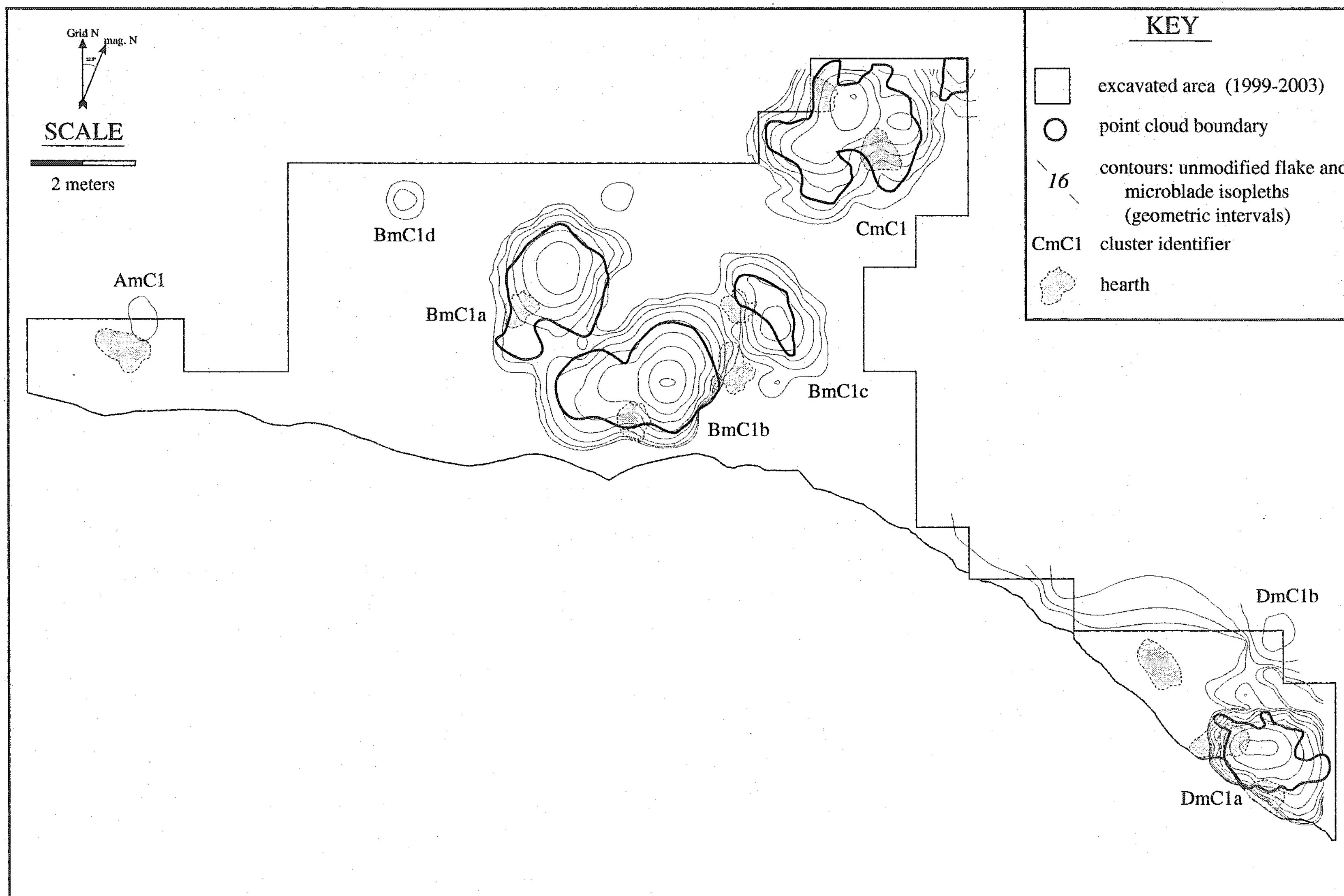


Figure 10.10 Component 3 gray chert (C1) distribution.

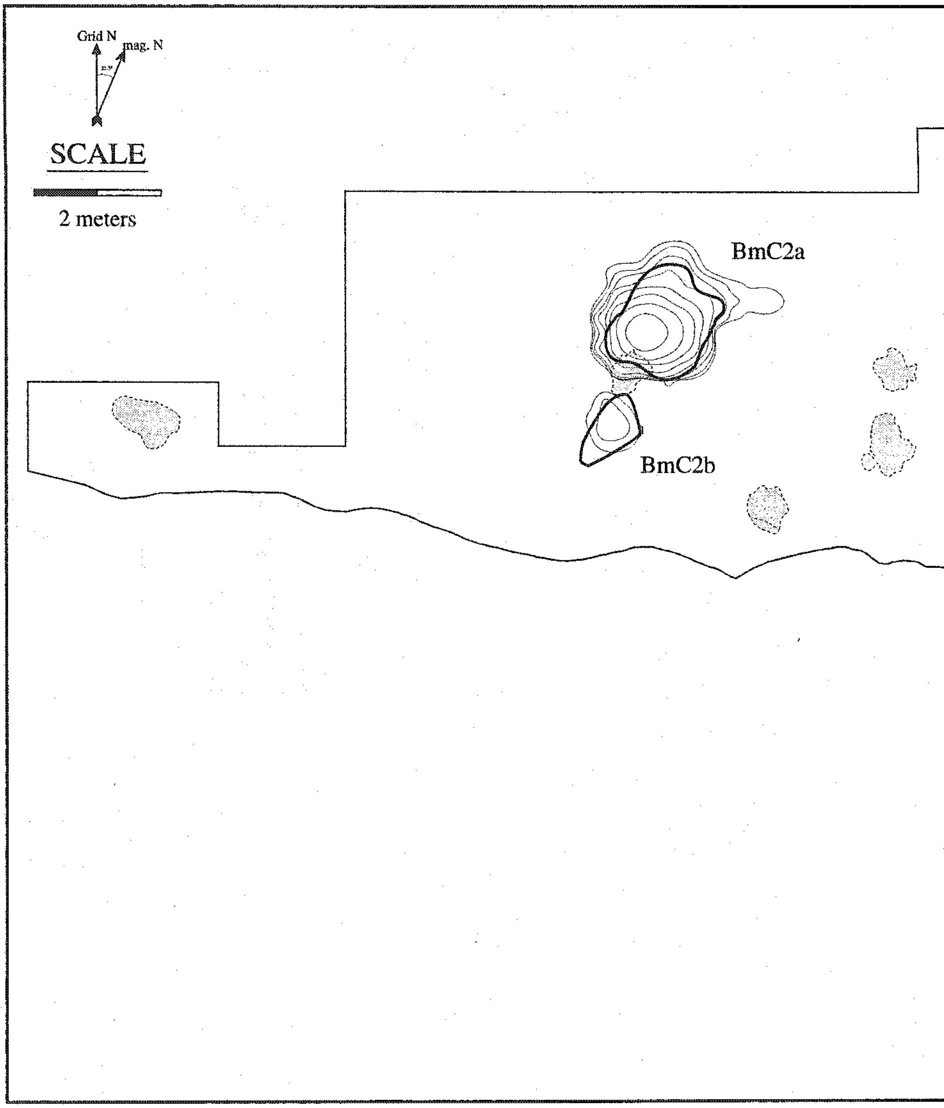
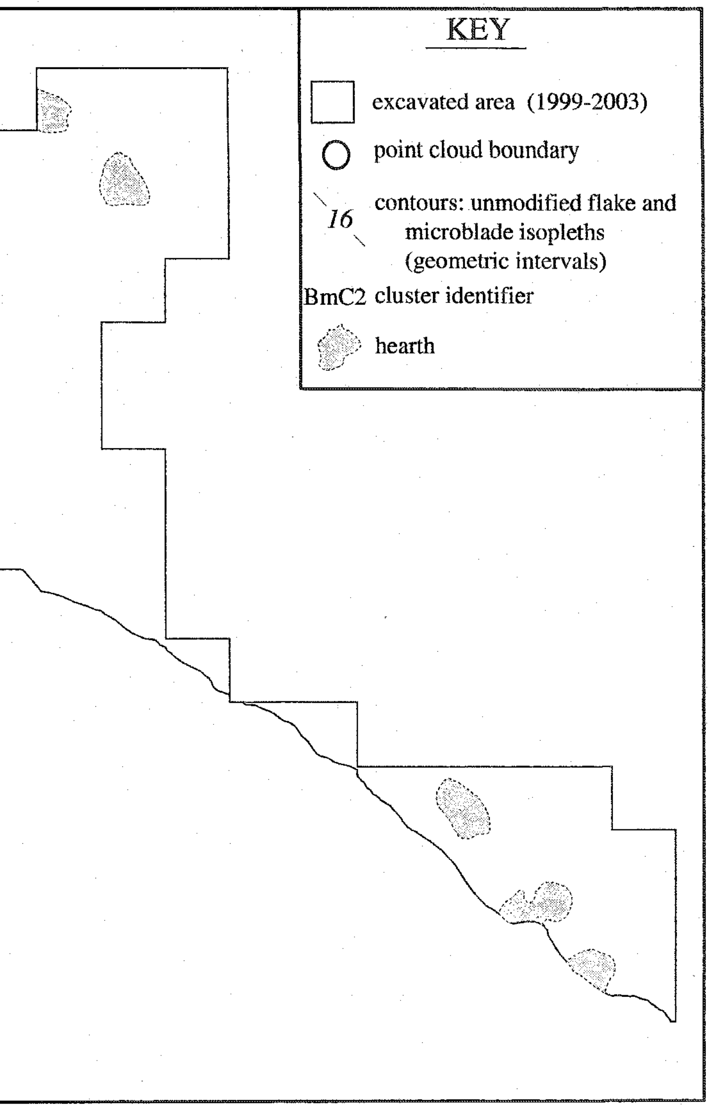


Figure 10.11 Component 3 light gray and black banded chert (C2) distribution.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BmC2 cluster identifier
hearth

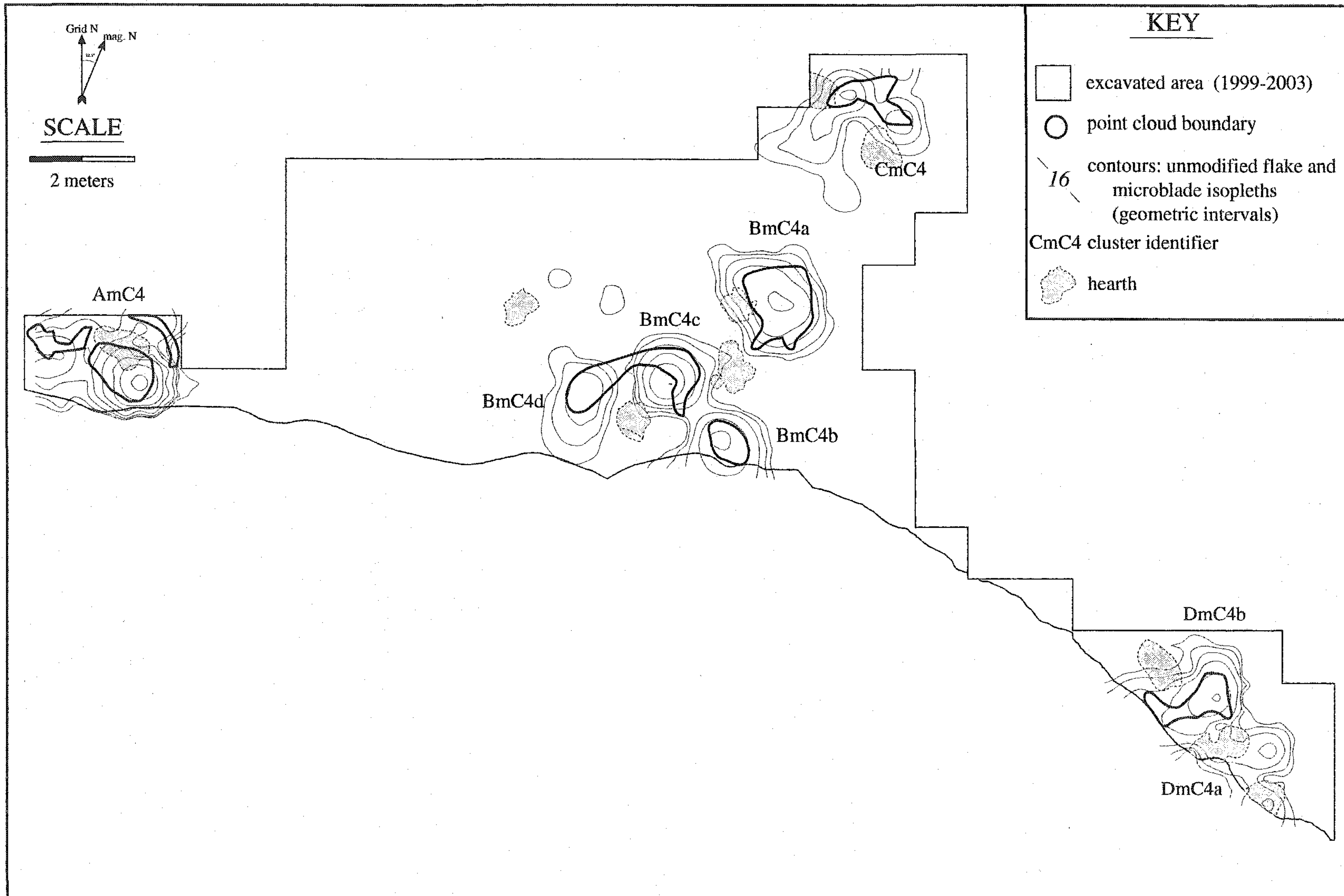


Figure 10.12 Component 3 black chert (C3) distribution.

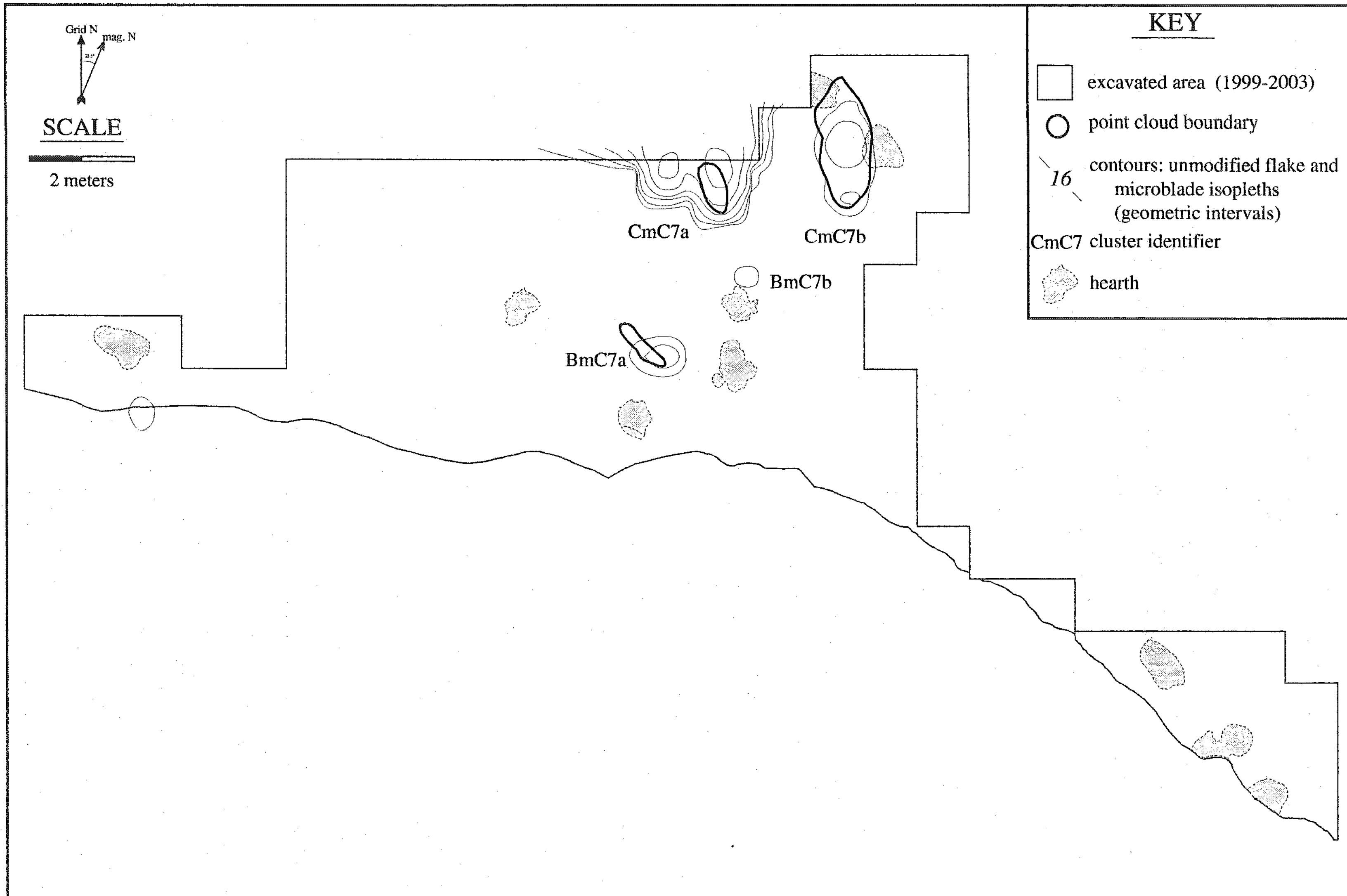


Figure 10.13 Component 3 tan mottled chert (C7) distribution.

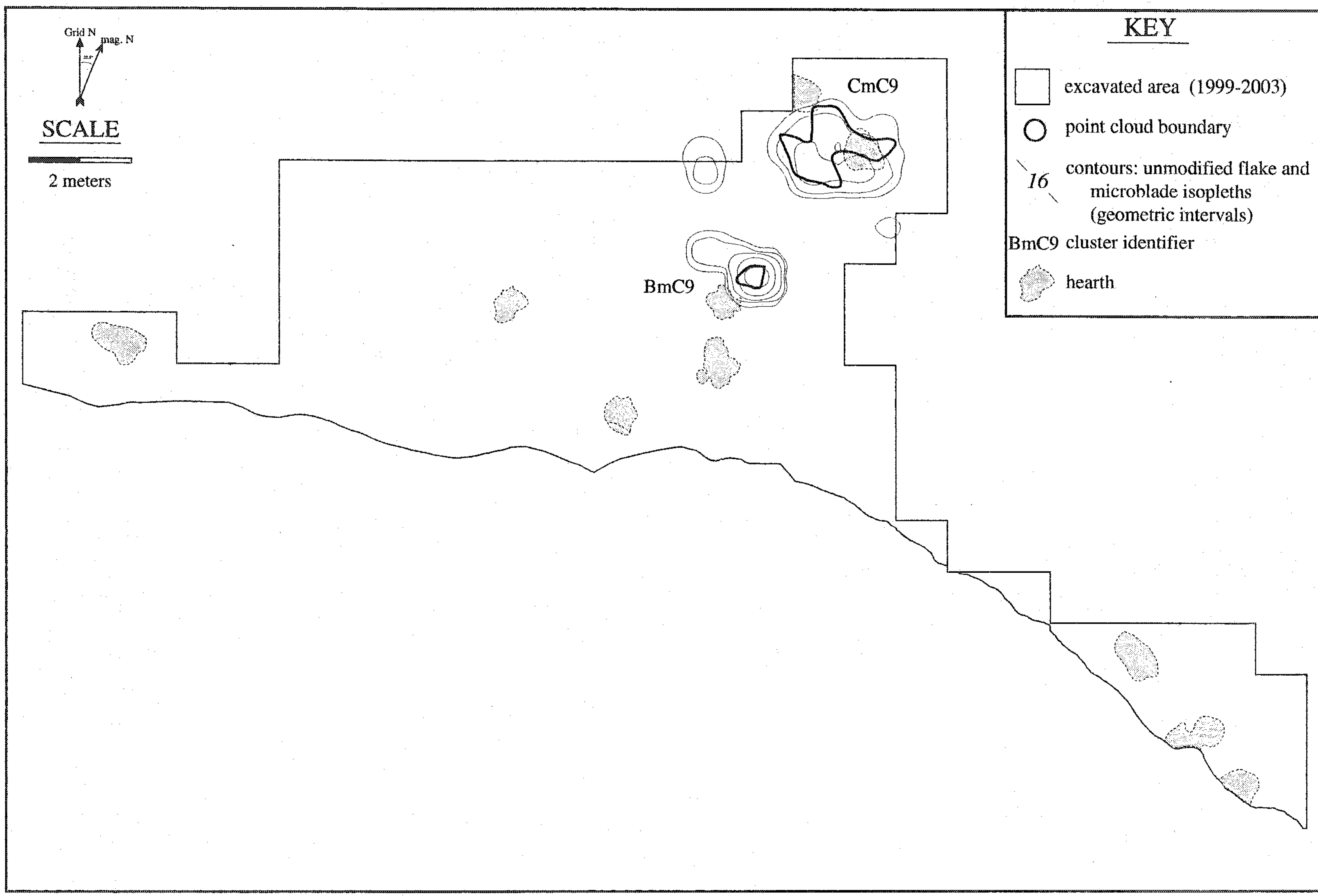


Figure 10.14 grayish-brown chert (C9) distribution.

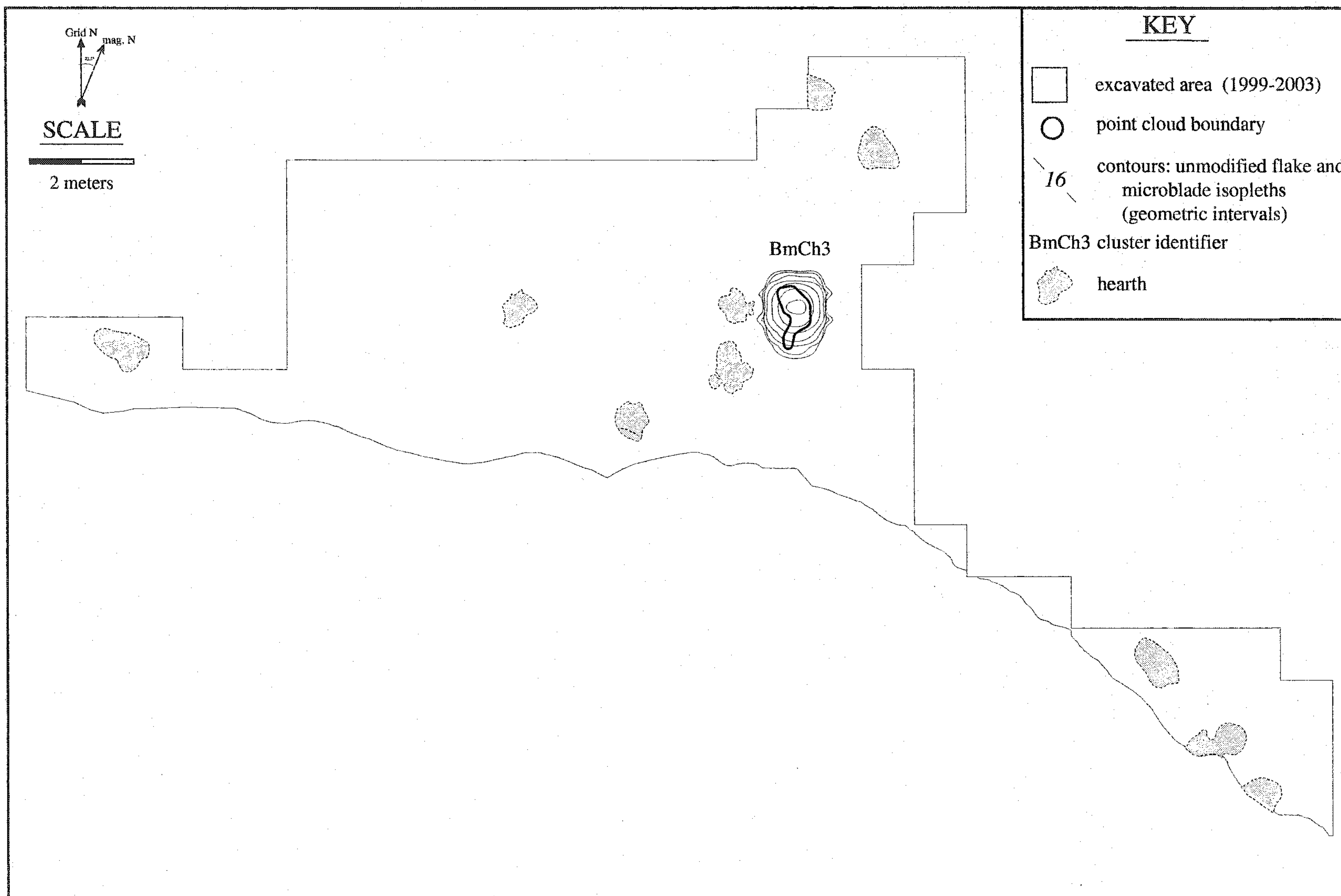


Figure 10.15 Component 3 red and black banded chalcedony (Ch3) distribution.

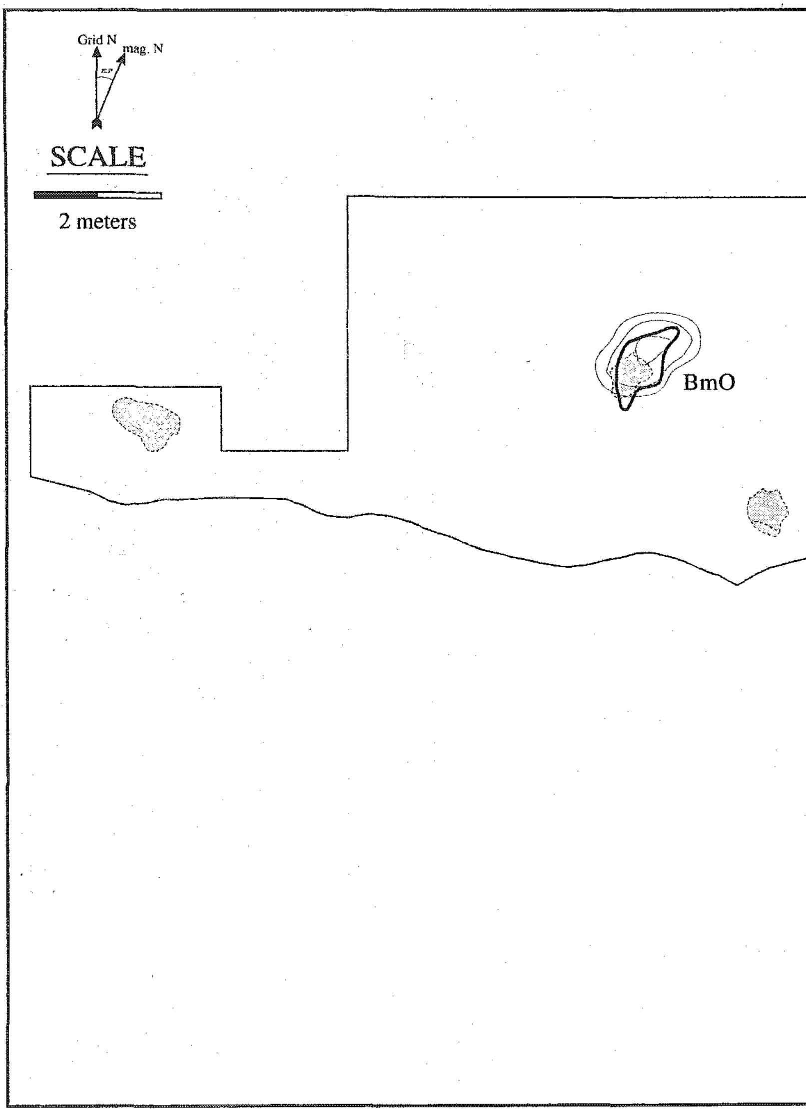
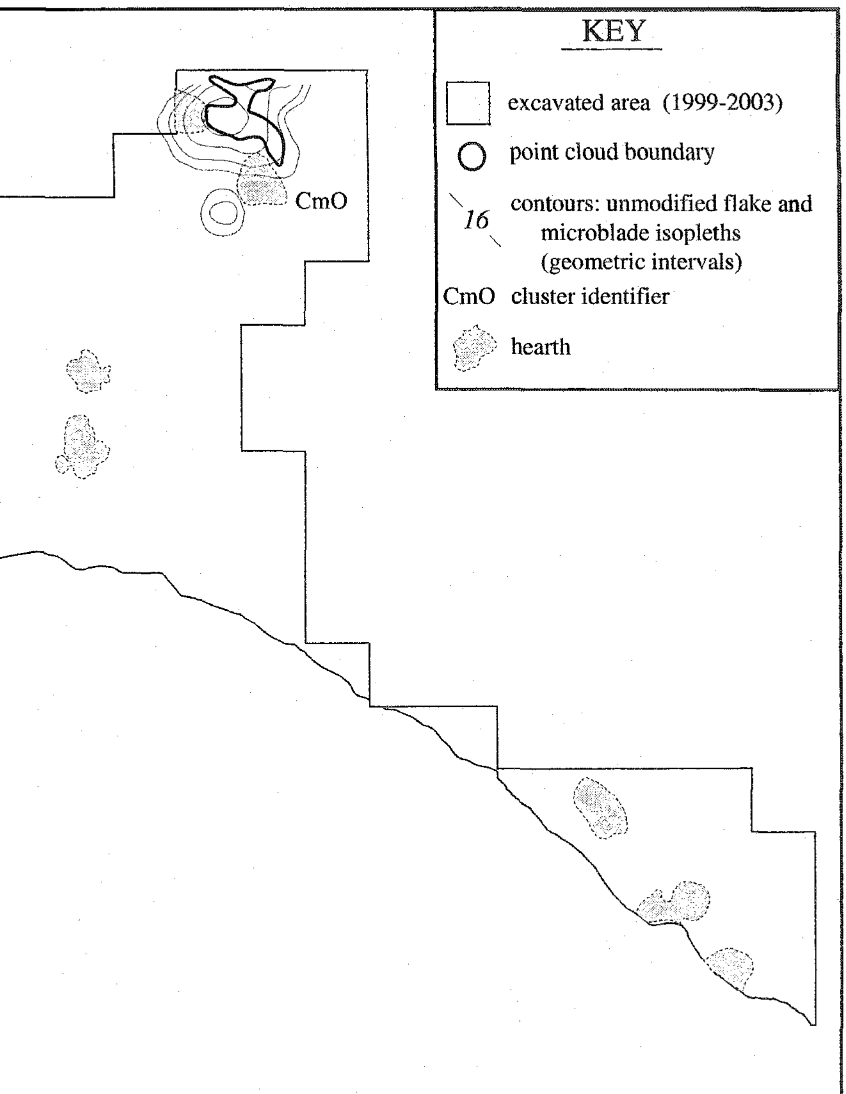


Figure 10.16 Component 3 obsidian (O) distribution.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hearth
CmO

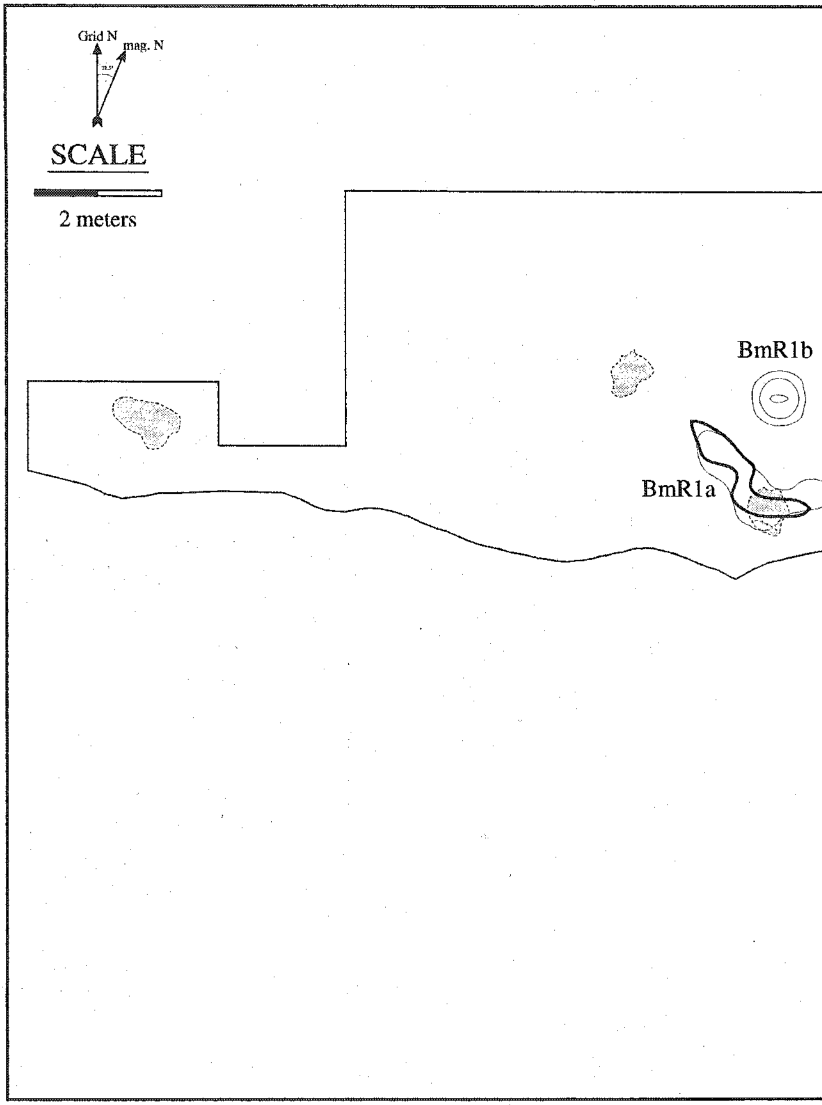
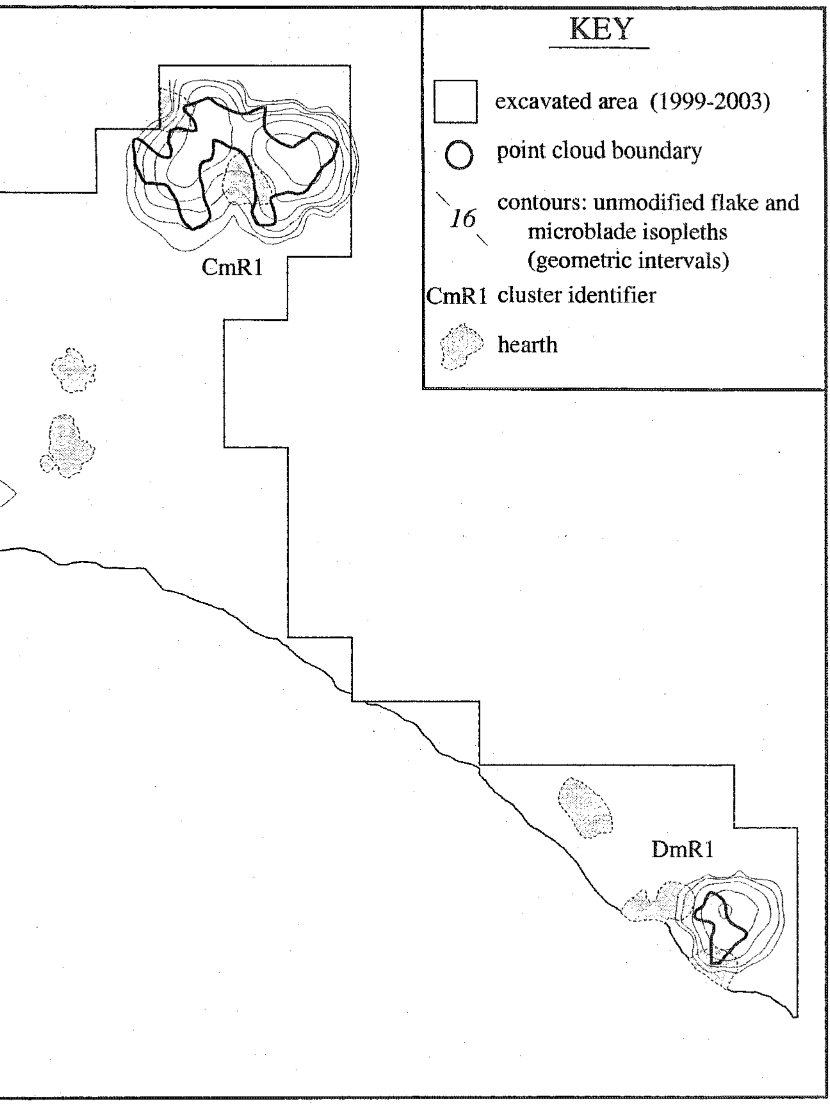


Figure 10.17 Component 3 gray rhyolite (R1) distribution.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CmR1
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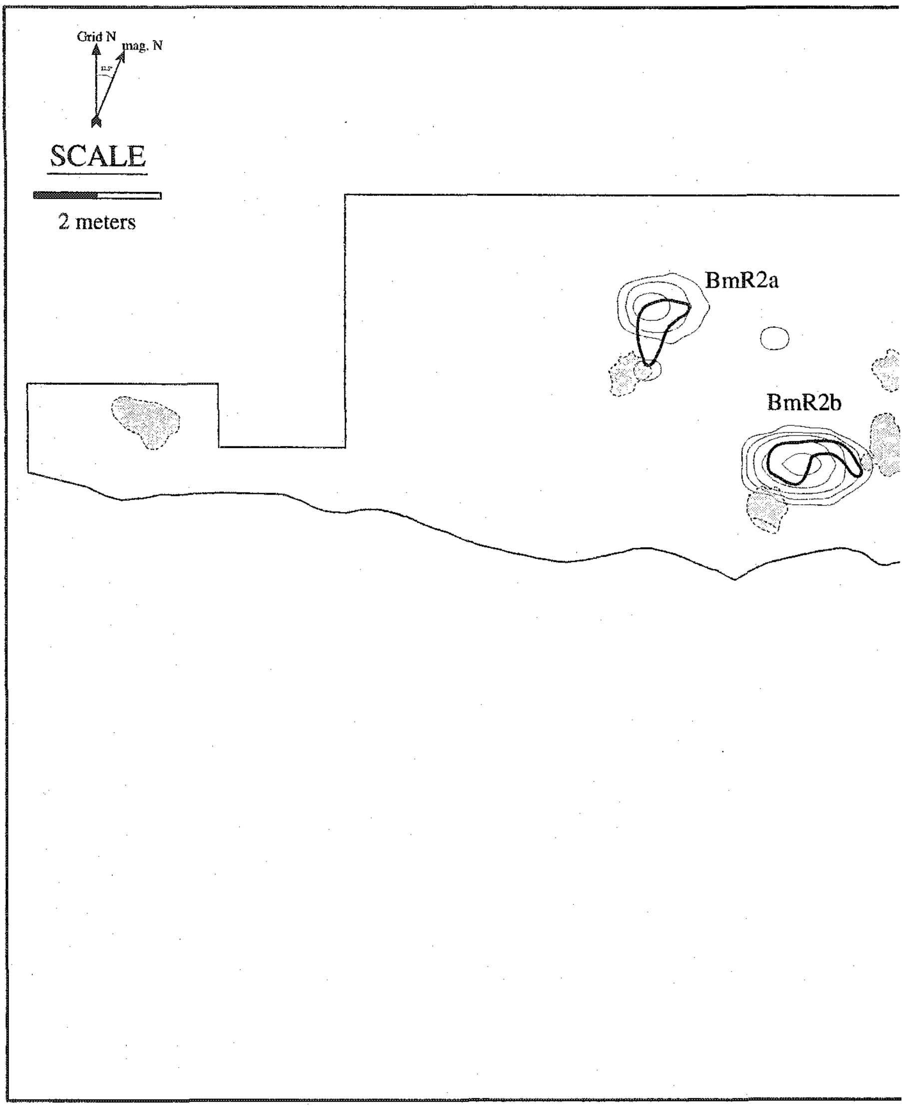
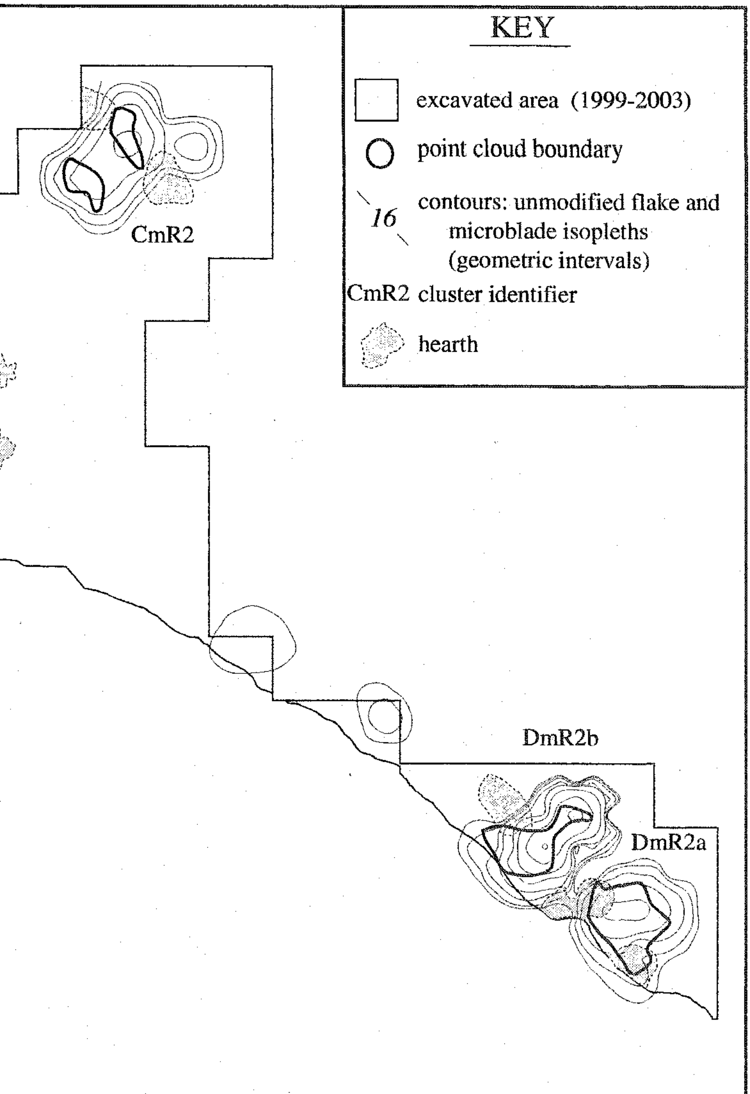


Figure 10.18 Component 3 white rhyolite (R2) distribution.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CmR2 cluster identifier
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CmR2
DmR2b
DmR2a

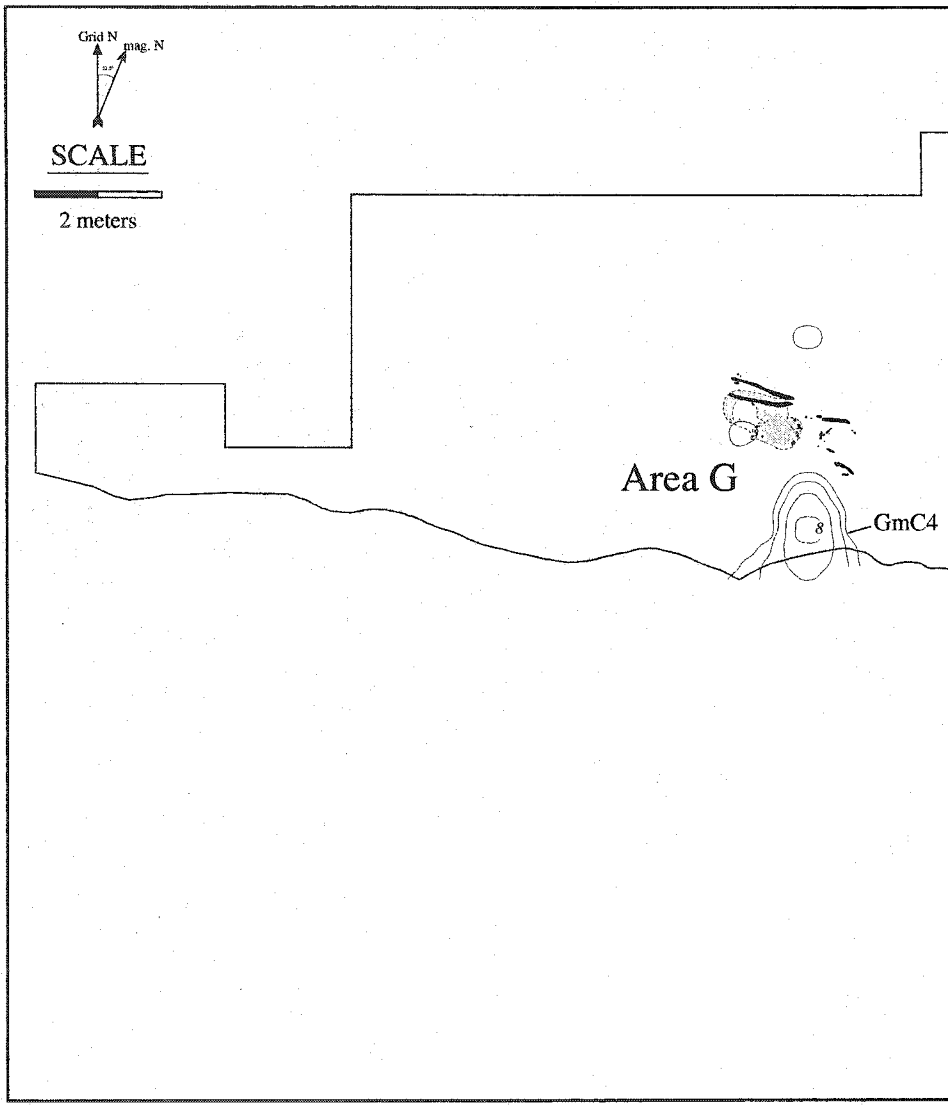
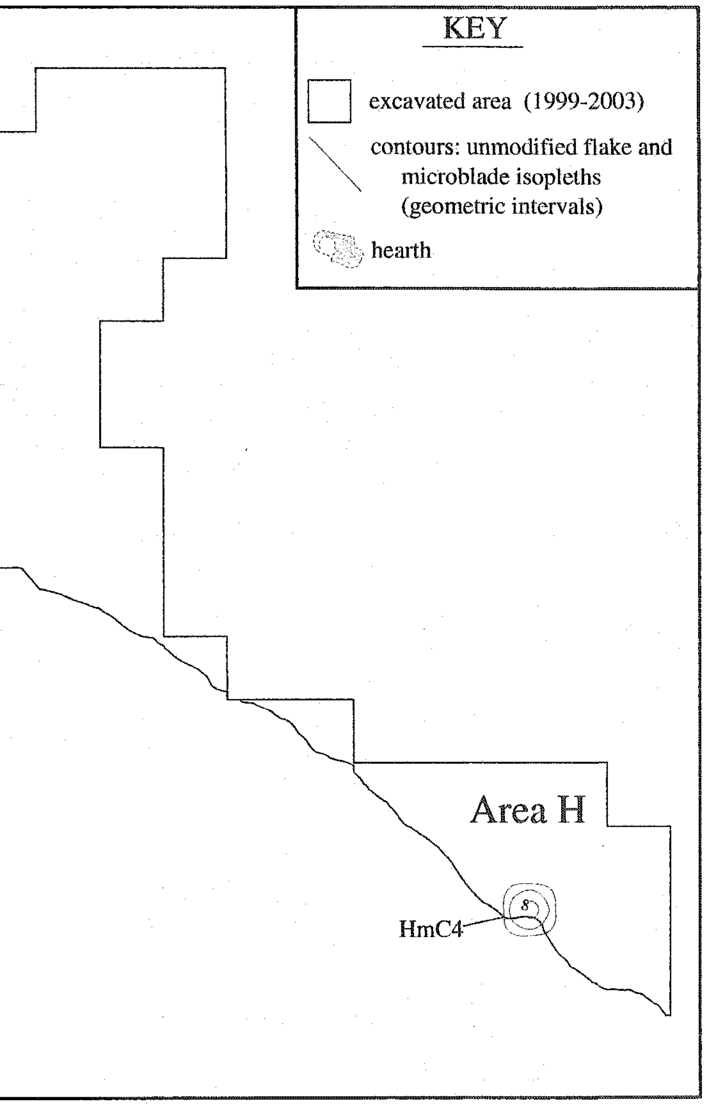


Figure 10.19 Component 4 material type (cluster) distributions and lithic areas.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hearth
Area H
HmC4
8

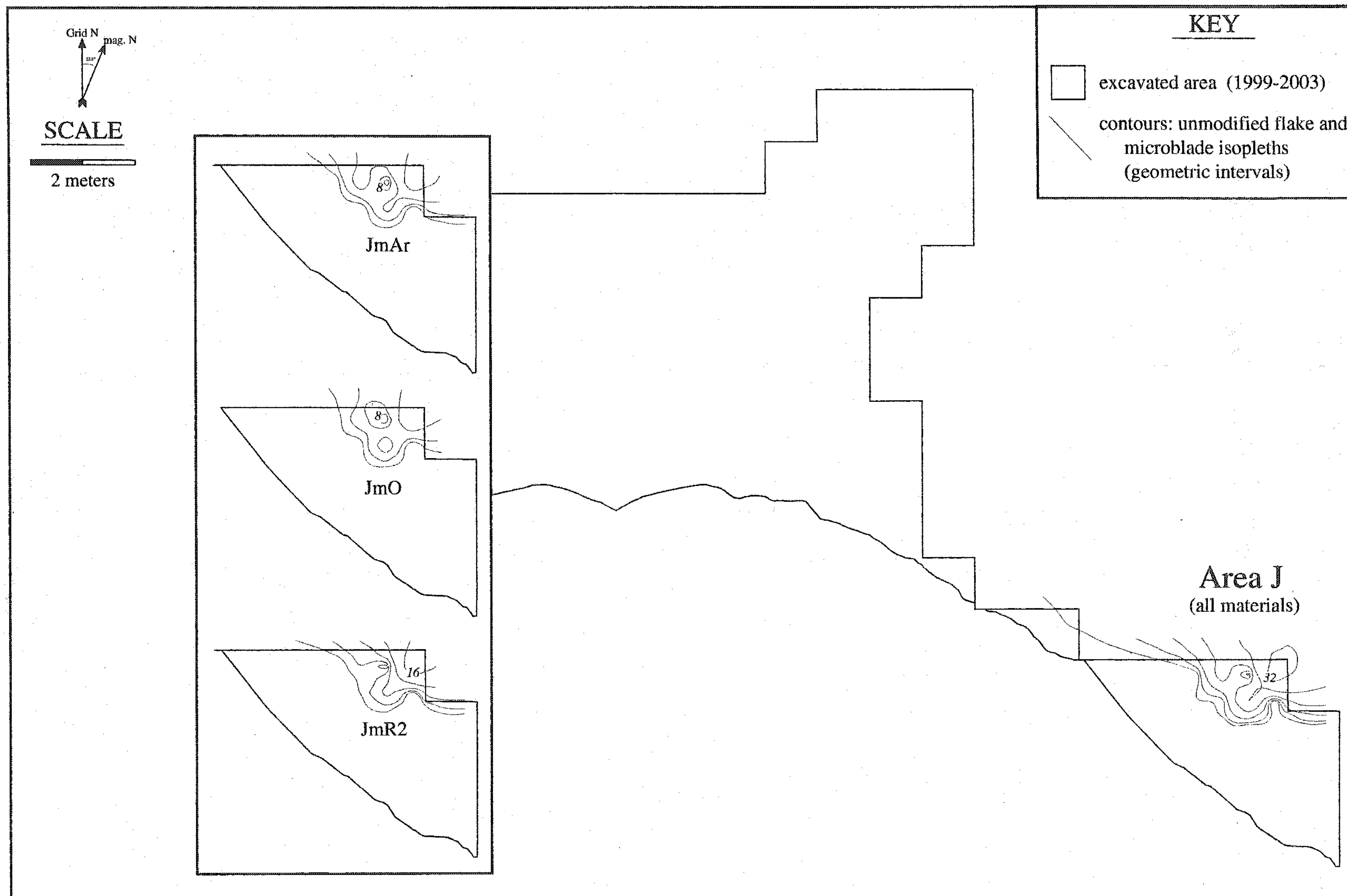


Figure 10.20 Component 5 material type (cluster) distributions and lithic areas and subareas.

Material types distributions among these three subareas were examined in order to assess the demarcation of subareas. All lithic raw materials in this area were totaled and the percentages of each material type within each subarea were compared. Table 10.3 lists the material types and percentages in each subarea. With these data, Subarea C3 appears different than C2 and C4, with exclusive occurrence of B, C6, C8, and S all at low frequencies. Subarea C3 also has the highest occurrence of O and Ch2. Subarea C2 had high percentages of C3 and C7. Subarea C4 had high percentages of An. It is difficult to disentangle possible superimposed occupations in this area suggested by the radiocarbon analysis (Chapter 5). While the nine material types with greater than ~70% or exclusive occurrence in one subarea can reasonably be assigned to a subarea (n=213, 13% of total), the remaining six material types cannot be definitively assigned (n=1365, 77%). Materials C1, C4, and R1, constituting the majority of the remaining materials, likely represent multiple flaking episodes (see Figures 10.10, 10.12, and 10.17). Thus, for the purposes of the analyses presented below, potential differences based on the nine material types that are assigned to specific subareas are explored, but other material types are examined at a level where Subareas C2, C3, and C4 are collapsed into one aggregate.

Subarea C3 contained more material types than the other two (15 vs. 11-12). Evenness values (SDI, see Chapter 8) indicate that the three subareas have relatively evenly distributed material types (SDI=0.91-0.93). Given the patterns of material type distributions and locations, Subarea C3 may be associated with an earlier component, perhaps associated with Feature 18, and Subareas C2 and C4 may be associated with Feature 12.

Table 10.4 lists summary data at the level of subarea and area. Analytical area is based on 0.25 m^2 quadrants encompassing the artifact concentrations. In some cases these overestimate the area of the lithic scatters since a small number of fragments are located at the peripheries. A more circumscribed area was derived from outlining the point clouds for each area and deriving the surface area within ArcView™, these values and derivative density values are provided in Table 10.4 in parentheses. For density values to be meaningful, one must control for effects of area excavated. A more valuable variable is number of lithic items (and weight) per m^2 where at least one item occurs. In this way, one could control for large areas where flakes do not occur. The method used here is to combine all flaked artifact counts and weight totals (excluding tci-thos) for each subarea, area, and component. Then all 0.25 m^2 quads containing at least one measure are enumerated. Area of occurrence is derived from this, and density values can be calculated. The resulting density values are shown for each subarea and area in Table 10.4. Data from this table are used in analyses in the subsequent sections.

Table 10.3 Material type relative frequencies for each subarea in Blocks T and X[5].

Material	*Total N*	*Subarea C2*	*Subarea C3*	*Subarea C4*
An	112	1	11	88
B	2	0	100	0
C1	765	28	51	20
C3	13	92	0	8
C4	67	27	42	31
C6	2	0	100	0
C7	28	64	21	14
C8	1	0	100	0
C9	50	44	14	42
Ch2	17	24	71	6
D	6	0	67	33
J1	5	20	40	40
O	59	7	76	17
R1	354	17	25	58
R2	96	36	49	15
S	1	0	100	0
Total	1578	n=391	n=651	n=537

[5] Shaded cells represent raw materials assigned to each subarea.

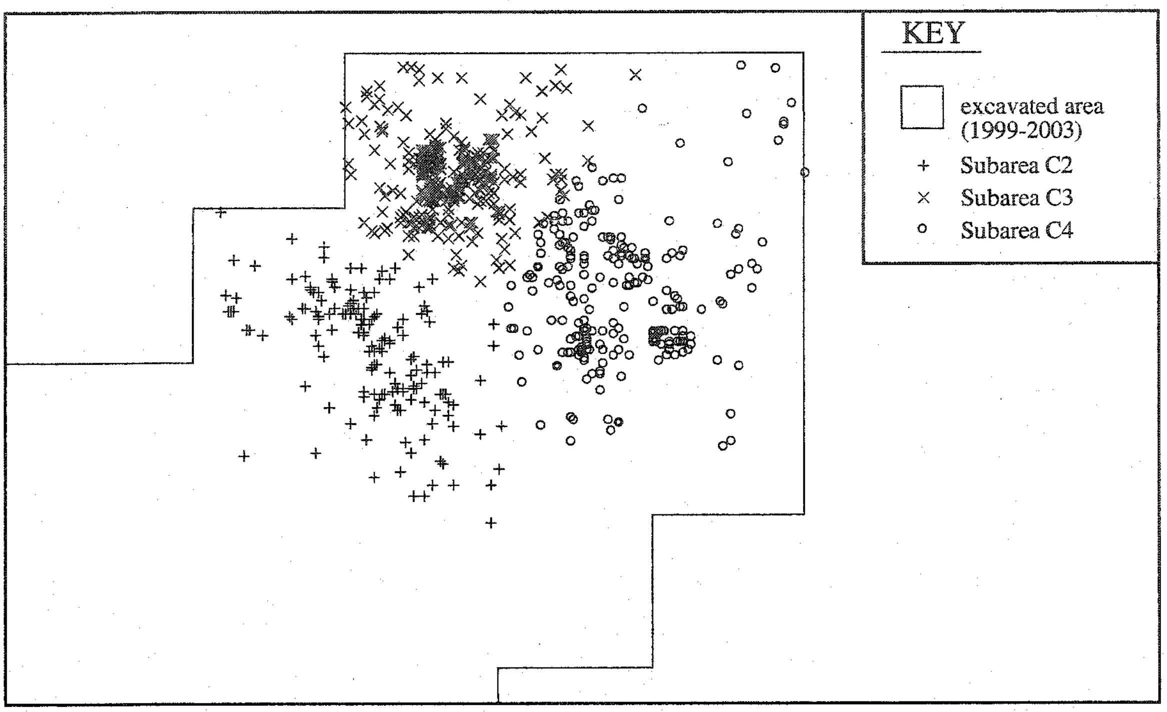


Figure 10.21 K-means 3-cluster solution for the eastern lithic subarea in Area C.

Table 10.4 Subarea and Area level summary data.

Area	Analytical area (GIS area) (m^2)	N items	Flakes	Micro blades	Cores	Tools	Total weight (g)	Count density* ($n/(m^2)$)	Weight density* ($g/(m^2)$)	Micro-blade wt. %†	Tools
A	5.5 (4.4)	811	589	219	-	3	65.41	147 (184)	12 (15)	100	1 BU, 2 MF, 23 MMB
B	25.1 (11)	2657	2197	417	10	33	272.23	106 (242)	11 (25)	67	1 BIF, 15 BS, 1 ES, 14 MF, 60 MMB, 2 SS, 4 BSS
B1	6.3 (3.2)	932	757	161	2	12	58.77	148 (291)	9 (18)	39	6 BS, 6 MF, 34 MMB, 1 BSS
B2	12.5 (4.9)	1296	1027	242	8	19	133.84	104 (264)	11 (27)	96	1 BIF, 8 BS, 1 ES, 8 MF, 22 MMB, 1 SS, 3 BSS
B3	5.3 (2.0)	369	356	12	-	1	77.40	70 (185)	15 (39)	7	2 MMB, 1 SS
B4	1.0 (0.5)	57	55	1	-	1	2.13	57 (114)	2 (4)	0	1 BS, 1 MMB
C	15.9 (9)	1758	1206	489	8	55	193.40	111 (195)	12 (21)	94	15 BS, 1 BU, 38 MF, 40 MMB, 6 BSS
C1	4.0 (0.8)	164	116	44	3	1	14.72	41 (205)	4 (18)	100	None (1 BU was found ~1 m to the south)
C2	4.8 (2.4)	391	252	123	1	15	29.05	81 (163)	6 (12)	94	10 BS, 5 MF, 15 MMB, 1 BSS
C3	2.3 (2.3)	650	482	144	3	21	73.98	283 (283)	32 (32)	93	1 BS, 1 BU, 19 MF, 13 MMB, 3 BSS
C4	4.8 (3.3)	537	346	173	1	17	47.99	112 (163)	10 (15)	93	4 BS, 13 MF, 12 MMB, 1 BSS
D	10.3 (4)	1851	1599	225	8	19	257.68	180 (463)	25 (64)	64	1 BIF, 2 BS, 2 ES, 13 MF, 11 MMB, 1 BSS
D1	4.8 (2.8)	1305	1098	187	4	14	192.32	272 (466)	40 (69)	93	1 BIF, 2 BS, 1 ES, 10 MF, 9 MMB
D2	5.5 (1.3)	529	486	38	1	4	57.74	96 (407)	10 (44)	16	2 ES, 2 MF, 2 MMB, 1 BSS
E	7.0 (4.0)	488	369	105	6	8	46.18	70 (122)	7 (12)	89	7 BS, 1 MF, 13 MMB
F	2.0 (0.5)	340	336	-	-	4	13.23	170 (680)	7 (26)	0	1 BS, 1 ES, 2 MF, 1 BSS
G	3.0 (2.2)	28	27	-	-	1	5.69	9 (13)	2 (3)	0	1 MF
H	0.3 (0.5)	15	5	1	-	9	12.44	50 (30)	41 (25)	0	1 BU, 8 MF
J	5.5 (5.7)	86	86	-	-	-	2.78	16 (15)	1 (1)	0	none
K	21.8 (24.2)	2040	2034	-	-	6	161.52	94 (84)	7 (7)	0	2 BIF, 1 BS, 3 MF
Total		10074	8448	1456	32	137	1030.56				

Note, 37 items were found outside Component 3 subareas and are not included in these totals.
* Density values in parentheses are based on GIS area estimates
† Microblade weight percent derived by dividing the sum of modified weights of clusters with microblades by the total modified weights per spatial unit.

Areas, Components, Loci, and Site

The third level of aggregation is the *Area*. Each area is defined as a spatial concentration of lithic debris separated from other debris by at least two m and in some cases by over 10 m. A total of 10 areas were identified for the five main components (one in Component 1, two in Component 2, four in Component 3, two in Component 4, and one in Component 5). This level may correlate with activity areas. Areas are illustrated in Figures 10.3, 10.5, 10.7, 10.19, and 10.20.

The fourth level of aggregation is the *Component*. Each component is defined based on stratigraphy and radiocarbon chronology (Chapters 4 and 5). Research questions at this level of aggregation relate to component differences in technological organization and assemblage composition (see Chapter 8).

The fifth level of aggregation is the *Locus*. This includes all of the *in situ* components, as well as material from disturbed contexts at the Lower Locus. Research questions related to this unit of aggregation include linking disturbed materials with *in situ* components on the basis of typology, technology, and material type (see Chapter 7).

The sixth and highest level of aggregation is the *Site* as a whole. This includes material from both Upper and Lower Loci, as well as material from disturbed contexts. The loci are best described as different sites in terms of topography, elevation, relief, and aspect (see Chapter 3). However, the high-resolution data acquired at the Lower Locus cannot be readily compared to the Upper Locus data in any way except for gross tool typologies, faunal presence/absence, and general stratigraphy (see Chapters 3 and 4).

Spatial Boundary Assessment

Assessing the boundaries and spatial contiguity of each subarea and area is important for understanding the use of space. If an area is truncated or only partially excavated, this may affect abundance and relative frequencies of cultural materials. Area A is truncated by the bluff edge (Figures 10.6-10.7). The highest density of microblades and flakes were south of Feature 10 at the southern bluff edge. This suggests that cultural material existed further to the south. The northern boundary of Area A is considered to be present and excavated, given the drop-off of lithics to the north, west, and east. Given these data and the large number of lithic items (n=810), Area A is considered to be adequately represented by the excavated materials.

Subareas B1 and B3 are considered to be totally excavated given the spatial distribution of artifacts (Figures 10.6-10.7). Subarea B2 has been truncated by the bluff edge to the south, though the western, northern, and eastern boundaries have been excavated. A portion of Block N slumped off in May 2000, but all of the matrix was screened, resulting in only 3 microblades and 13 flakes (all of gray chert). This limited quantity of materials indicates a high drop-off of lithics to the south, suggesting that almost all of Subarea B2 was excavated.

Subarea B4 is a small group of flakes (n=57) separated from B2 to the southeast. While the southern edge is likely truncated by the bluff edge, the small size and limited diversity suggests that the excavated materials are representative of this Subarea. Subarea C1 appears to be mostly excavated given the three-pointed distributions (Figure 10.6), though a few specimens likely remain to the north.

Subareas C2-C4 are considered to be mostly excavated given the three-pointed distributions (Figure 10.6). Subareas C2 and C4 are probably totally excavated, however, Subarea C3 may have more materials present to the west. Feature 18 is only partially excavated, and there are likely more materials within EU N53E47. The density data for this area shows a decrease to the north and west suggesting that the excavated materials are representative for Subarea C3.

Subareas D1 and D2 are truncated to the southwest by the eroding bluff edge. The eastern and northern boundaries are considered to have been complete excavated. Given the numbers of lithics present in these subareas (n=1305 and 429 respectively), the excavated materials are considered to be representative of these Subareas.

Area E is considered to be completely excavated (Figures 10.4-10.5). Area F may also be almost completely excavated. Though Feature 17 is truncated by the bluff edge, very few lithic artifacts were found within 25 cm of this feature. Given the close association of the vast majority of lithics with Feature 19 (cobble ring), most of Area F is considered to have been excavated, though some artifacts may still be present to the north.

Areas G and H are considered to be nearly completely excavated given their limited spatial extent and small size (n=28 and 15 respectively) (Figure 10.19). Both areas are truncated to the south by the bluff edge. The excavated materials in Area J are not considered to be representative of the area as a whole, given that most of the materials are located at the edge of the excavated area to the northeast. The western, eastern, and northern edges of Area K have been excavated, but the southern edge has been truncated by the eroding bluff edge. Given the number of artifacts (n=2040) and spatial extent, the excavated materials are considered representative of the area.

Six hearth features have complete drop zones excavated, Features 1, 2, 5, 7, 9, and 12, and two others have been nearly completely excavated, Features 3 and 10 (see Figures 9.2, 9.9, and 9.44). One hearth may be excavated totally in the future (Feature 18), but the remaining hearths were found near the edge of the eroding bluff (Features 13, 14, 16, and 17).

In sum, with the exception of Area J, the areas and subareas are considered to be completely excavated or excavated to the point where the assemblages could conservatively be considered representative of the areas. Boundaries for most of the areas, defined by the three-pointed distributions and contour isopleths, could be established for at least the majority of the peripheries.

Refitting Analysis

Refitting analysis can provide useful insights into spatial patterning, lithic reduction sequences, technical organization, and technological relationships among different areas within components (Jodry 1987; Seeman 1994; Morrow 1996; Bleed 2002; see review in Hofman 1992). The objectives of the Gerstle River refitting analysis are to (1) assess boundaries of lithic concentration areas, (2) assess contemporaneity among the areas and (3) compare spatial data for specific technological types (among tools, cores, and debitage groups) in order to reconstruct behaviors relating to the use of space for microblade production and core and tool maintenance and disposal.

A limited refitting program focused on tools, tool fragments, utilized microblades, and larger flakes in Components 1, 2, 3, and 4 and rare material types found across the site. Problems with refitting across the site are the generally small size of the debitage and the relative paucity of tool manufacturing detritus, as inferred from the general lack of cortex and large flakes. As described in Chapter 8, 90-92% of all lithic items in Components 1, 2, and 3 were smaller than 15 mm, and between 73-79% were smaller than 10 mm. Two types of relationships were examined, refits and conjoins. Refits refer to two or more pieces sequentially detached from a parent core or tool where the dorsal surface of one refits to the ventral surface of another. Conjoins refer to one flake that was broken and associated on the basis of edge refitting.

Expectations based on the very small debitage sizes and the homogeneity in each lithic concentration include the predominance of very short distances between refits/conjoins, very little interlinking among lithic areas and subareas for unmodified flakes, microblade cores and core parts, and microblades and modified microblades. Non-microblade tools are expected to have greater distances between refits due to their heavier size (hence, possibility to be tossed on disposal), and potential for curation between resharpening, rejuvenation episodes and final disposal.

Horizontal distances between refits were examined to characterize contemporaneity between areas of each component and dispersion within areas. Differences in horizontal distances for different tool, core, and debitage types were used to assess differential disposal or tool use. While no core tablets could be directly refitted to the two microblade cores in Component 3, flakes and microblades detached from these cores were used to assess spatial patterns relating to microblade production, core maintenance, and core disposal.

Even with the limited potential for refits, 89 items in 39 groups were refit or conjoined within Components 1, 2 and 3. There were two groups with four conjoined or refitted fragments, seven groups with three fragments, and 30 groups with two fragments. For each refitted or conjoined pair, the distance was obtained by adding the square east and north distances and taking the square root, thus giving the diagonal difference between each pair. A small number of refits or conjoins were provenienced within a quadrant (0.25 m^2) (n=8, or 9% of total). These items were assigned values at the center of the quadrant (i.e., N47.75, E50.25 for N47.50-48.00, E50.00-50.50). For groups where n>2, distances were calculated among all specimens, thus yielding 59 distances, one for Component 1, six for Component 2, and 52 for Component 3.

Component 1 had two conjoined unmodified flakes, at a distance of 20 cm. With further work, I believe that more of the larger flakes may be able to be refitted or conjoined. The spatial distribution of future refits may better define the horizontal disturbance when compared to Component 3 unmodified flake refit distributions. Differences in Andesite distribution may be useful in assessing the relationship between Clusters KmAna and KmAnb.

Component 2 had nine items conjoined or refitted to four groups, with distances between 16 and 144 cm, averaging 83±53 cm (Figure 10.22). A histogram of refit distances is illustrated in Figure 10.24. Two burin spall and two microblade conjoins were separated by 46 and 50 cm respectively. Four refit core-tablets were located further apart, at 16, 113, 130, and 144 cm. There were no refits between Areas E and F, suggesting they may have been produced by different occupations.

Component 3 had 52 items conjoined or refitted to 34 groups, with distances between 0 and 601 cm, averaging 62±88 cm with a mode of 52 cm (Figure 10.23). A histogram of refit distances is illustrated in Figure 10.24. With the exception of one refit distance, all of the distances were between 0 and 159 cm, and most (79%) were less than 100 cm. This distribution suggests deposition occurred within the same drop zone of the flaking episode and/or breakage.

In order to determine if refit/conjoin distances were different for different tool, core, and debitage groups in Component 3, a Kruskal-Wallis H test was conducted for specific groups. Mean distances, standard deviation, and range (in cm) for each group are listed in Table 10.5. The groups were different ($H=19.07$, $df=50$, $p=0.039$). Fisher's PLSD post hoc test showed that microblade core tablet distances were significantly different from microblades (mean difference of +111 cm) and modified flakes (mean difference of +112 cm). These differences are related to one outlier, core tablets located 6 meters apart. When this is removed, these differences are not significant, but core tablets are then significantly closer to each other than tci-thos (mean difference of –116 cm) and microblade core – unmodified flakes (mean difference of –66 cm). Coefficients of variation for most of the groups are high and ranges are generally wide, suggesting that the differences among the different groups likely relates to a general factor of flaking location rather than to specific differences in function or modes of discard that may relate to spatial location of refits/conjoins.

Four microblades refit to the black chert microblade core in Area D (UA2002-62-325). They were located between 68 and 125 cm from the discarded core, but lay only within 17-57 cm from each other (38 cm average), suggesting microblade manufacture within a limited area and then discard of the core about one meter away, near the edge of the activity area. Three flakes were detached from the gray chert microblade core in Area D (UA2003-54-1408). The flakes were located 43-121 cm from each other, and 66-120 cm from the core. While these distances are similar, the core itself was discarded over 50 cm to the south of the main Subarea D1 lithic concentration. Both of these distributions show that microblade cores were discarded in areas about 1 m away from their actual use in microblade production.

Table 10.5 Mean distance and range of refit/conjoins for Component 3 lithic groups.

Group	*n*	*Mean distance (cm)*	*cv*	*Range (cm)*
Burin spalls	1	159	N/A	159
MB core tablets	5	140±259	185	4-601
Short axis beveled flakes	1	51	N/A	51
Microblades	12	30±40	133	0-112
Microblade core parts	1	59	N/A	59
Modified flakes	13	54±46	85	4-111
Boulder spall scrapers	1	141	N/A	141
Flakes	6	62±39	63	2-101
Microblade core – microblades	6	69±41	59	17-125
Microblade core – flakes	6	91±31	34	43-121
Total	52	62±88	142	0-601

The Component 3 data show varying degrees of connectedness between certain areas. No refits were found in Area A. Area B contained a number of refits/conjoins, mostly within Subarea B1. Interestingly, the concentration of tools within Subarea B2 shows a number of refit connections, all within that concentration, with none linked to the denser concentration in the eastern part of Subarea B2. The longest refit distance within Component 3 was between two core tablets 601 cm apart, one within Subarea B2, the other near Area D. Three metatarsal conjoins are found with a similar spatial distribution, one fragment in Subarea B2, the other two within Area D. Area C contained a number of refits/conjoins, most less than one meter. Several refits link Subareas C1 with C2, and perhaps C3. There are no refits/conjoins between Subarea C4 and any other Area C subareas. Area D had a number of refits, many related to the two microblade cores discussed above, one associated with Subarea D1, the other with Subarea D2. In general, the refits show discrete distributions with no overlap between the subareas.

Though the limited sample size of refits (0.5% of all Component 3 lithics) and the small debitage (*sensu lata*) sizes precludes definitive statements, the refitting analysis suggests that materials were generally deposited at or very near the point of detachment. While there are variations among tools, cores, and debitage classes, the overall refit distances were similar. One may infer from these patterns that specific locations were used for lithic reduction tasks, with little horizontal dispersal of related debris.

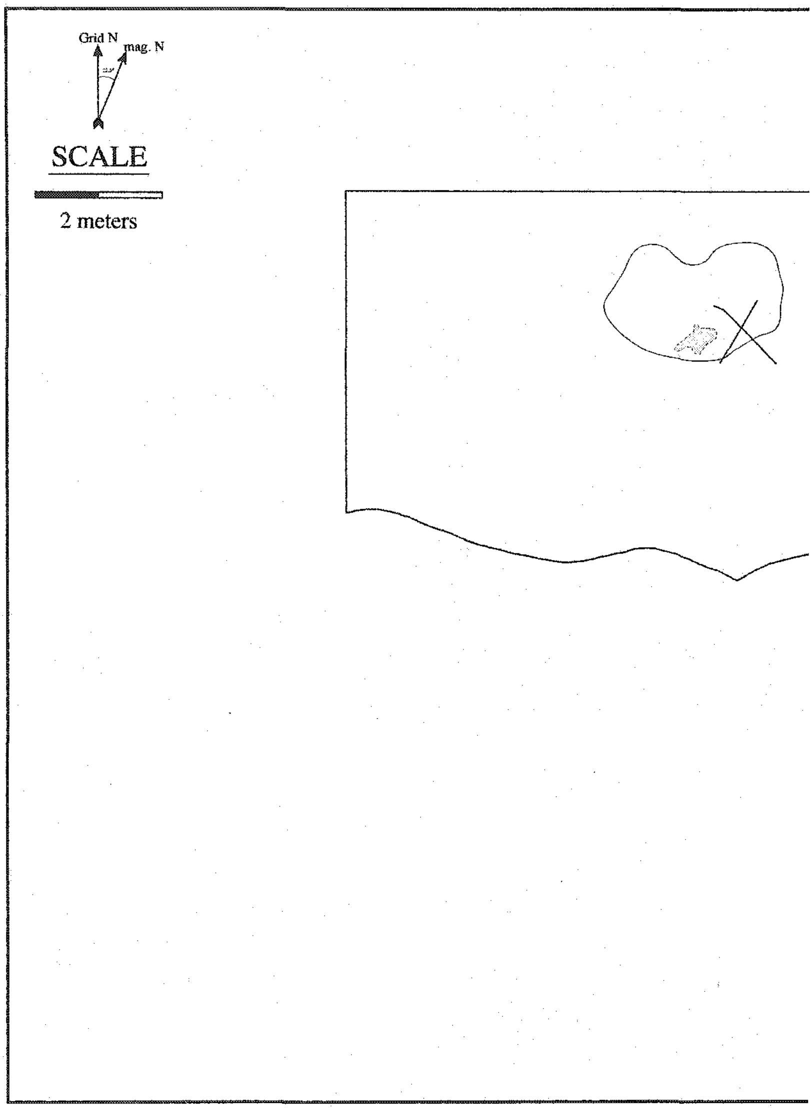
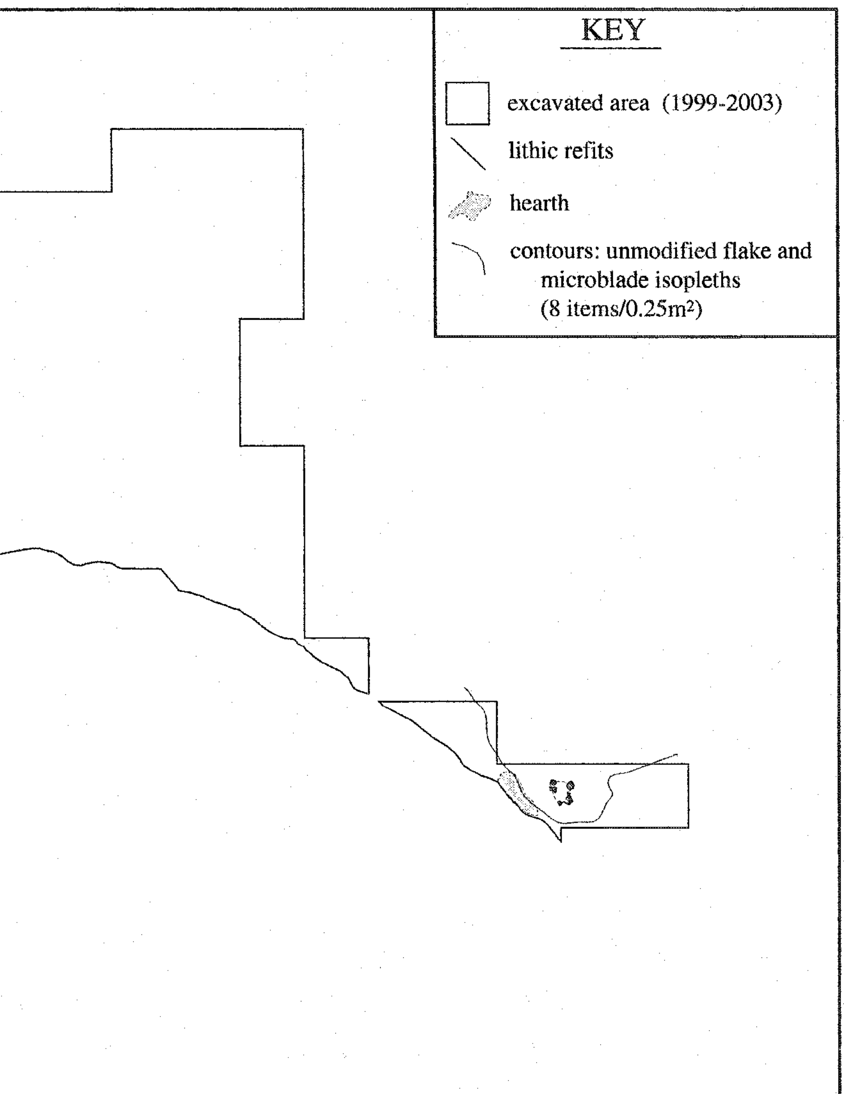


Figure 10.22 Component 2 lithic refits.


KEY
excavated area (1999-2003)
lithic refits
hearth
contours: unmodified flake and
microblade isopleths
(8 items/0.25m²)

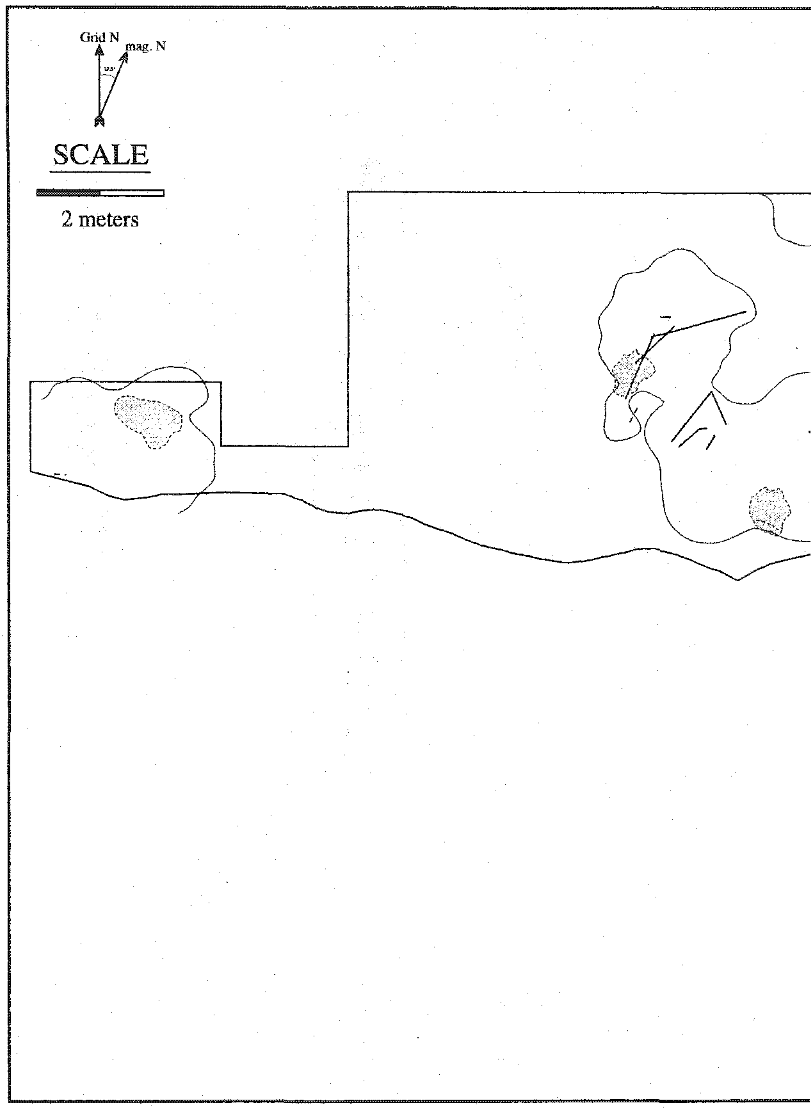


Figure 10.23 Component 3 lithic and faunal refits.


KEY
excavated area (1999-2003)
lithic refits
faunal refits
hearth
contours: unmodified flake and microblade isopleths (8 items/0.25m²)

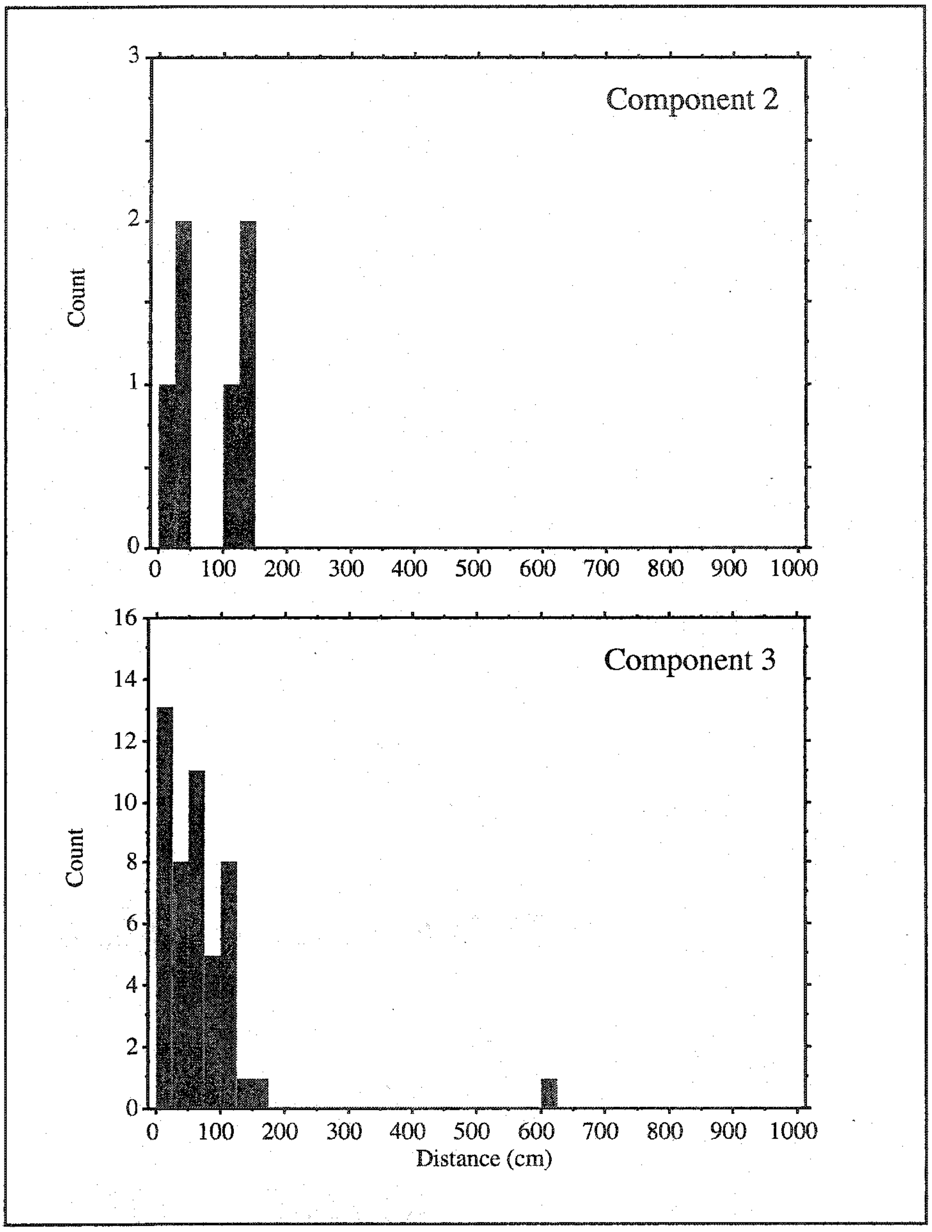


Figure 10.24 Refit and conjoin distance histograms for Components 2 and 3.

Cluster Level Analysis

Lithic clusters were divided on the basis of presence or absence of microblades. Table 10.2 lists cluster level summary data (where n>30 items). The presence of microblades can be used to demarcate the clusters, though this may partially mask clusters where microblade production and non-microblade related tool maintenance co-occurred. On this basis, 39 clusters (60% of total clusters) are defined as relating to microblade production, and 26 clusters (40%) are defined as relating to non-microblade tool maintenance. The spatial positions of these clusters in Component 3 are shown in Figure 10.25. There does not appear to be discrete segregation of clusters on the basis of technology, except for Subarea B3, where no microblades were found. This suggests that microblade production may have been embedded within other tool maintenance tasks, such as bifacial and unifacial tool resharpening and/or use. In other words, microblade production and bifacial/unifacial tool maintenance/use areas co-occurred as activity sets. Detailed analyses relating to microblade and non-microblade lithic clusters are presented below. The interrelationships among these are examined below in the Subarea level analysis.

Microblade Clusters

Because of the high resolution afforded at Gerstle River, I examined in detail microblade variables at the level of lithic cluster. There are a total of 39 clusters with at least one microblade, but given the low relative frequencies of microblades at six of these (1-10% of total items), they were excluded from further analysis. An additional 18 had less than 15 microblades and are not shown on the graphs that follow. The remaining 15 microblade clusters contained between 16 and 215 microblades each.

It is reasonable to suppose that microblade variables such as proximal width, percentage modified, type of modification, maximum dimension distributions, total frequency of microblades, segmentation representation, and percentage of microblades per cluster total are related in some fashion to microblade production and patterned variability among these variables may reflect underlying technological characteristics of microblade production, use, and discard. To detect possible patterning among these technological variables, I examined them in the context

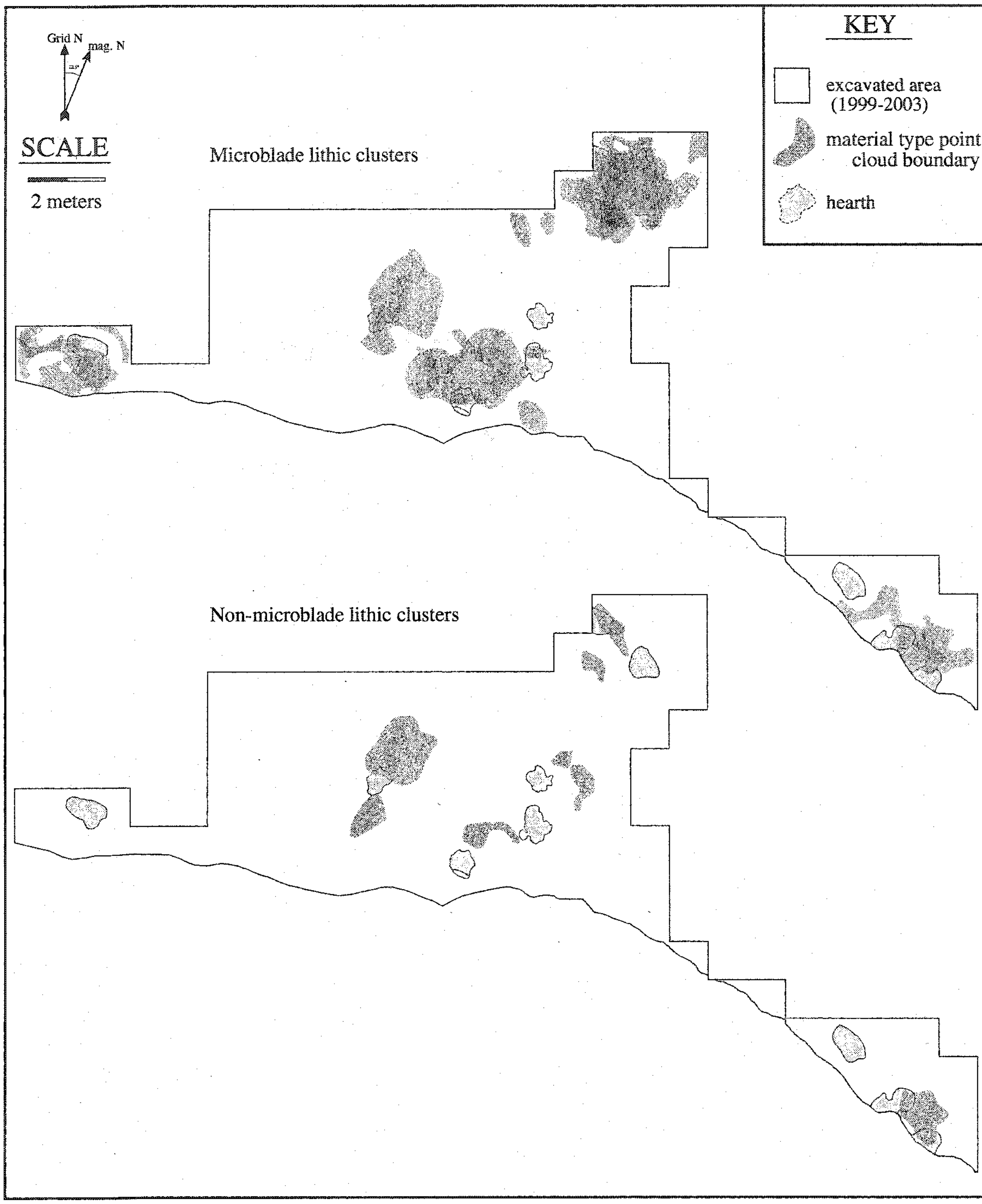


Figure 10.25 Comparison of Component 3 microblade and non-microblade clusters.

of the highest resolution Gerstle River can offer, the level of material type cluster, discrete loci within components.

There was a dichotomy in microblade number per cluster, with 27 clusters with between 1 and 64 microblades, and six clusters between 134 and 215 microblades. I designated the smaller clusters as Group A and the larger clusters as Group B. It was hypothesized these differences may relate to different uses or different stages in the microblade production process. These groups were tested for differences in segmentation representation and modified microblade percentages. While these groups did not have significant differences in segmentation (χ^2=5.1, df=3, p=0.165) or percentage of modified microblades (A=26±32%, B=8±3%, t=1.32, df=30, p=0.197), Group B showed much less variability in the latter (CV=4 vs. 124). While the Group B microblade clusters exhibited a narrow range of variability with respect to these two variables, the Group A microblade clusters likely contained more than one population. To identify patterns within Group A, I examined percentage of modified microblades (of total microblades) three groups were distinguished: Group A1 (n=12 clusters) contained 20-100% modified microblades, Group A2 (n=7) contained 6-10% modified microblades, and Group A3 (n=7) contained no modified microblades. Thus, the differentiation of these four groups, A1, A2, A3, and B was based solely on number of microblades and percentage of modified microblades only. It was thought that these variables would be most useful in distinguishing potential differences in microblade production. Summary variables are presented for each microblade cluster in Table 10.6 and for each microblade group in Table 10.7. Figures 10.26-10.32 are pie charts, line graph, and histograms illustrating differences among microblade groups.

These four groups have considerably different patterns with respect to segmentation representation, modification type (end and lateral), and maximum dimension distributions. It should be stressed that these variables are independent of the grouping variables. These microblade groups were significantly different with respect to segmentation representation (χ^2=76.524, df=9, p=0.000) (see Tables 10.6-10.7, Figures 10.26 and 10.27). Group A1 microblades had much higher percentages of medial segments (58% vs. 23-37%). Groups A2 and B were relatively similar with high frequencies of proximal fragments and somewhat less medial fragments with very few distal fragments. The main difference between Groups A2 and B were the higher percentages of complete microblades in the former. Group A3 is more divergent from these two groups, with higher percentages of distal fragments and very depressed medial percentages. Figure 10.26 shows pie charts for each cluster (where n>15). Group A2 microblade clusters show more internal variability than Group B, which shows a nearly identical consistency in segment representation. The fact that Group B are composed of very large microblade clusters, this distribution suggests that Group B microblade clusters resulted from a more systematic production process. The higher relative frequencies of complete microblades in Group A2 may reflect an earlier stage or less controlled stage of manufacture, with a number of initial microblade spalls that may be considered unusable and may suggest early stages with concomitant core reshaping. Group A2 microblade clusters (and CmC7a in Group A3) generally have relatively fewer medial segments when compared with Group B. This may indicate microblade production and selection of microblades for use in a tool and then carried off-site.

The microblade groups differ significantly with respect to relative frequencies of modified microblades (χ^2=55.125, df=3, p=0.000) (see Tables 10.6-10.7, Figures 10.27-10.29). Group A1 contains an average of 43% modified microblades, Groups A2 and B contain 8%, and Group A3 contains none. Relative frequencies of modification type (as a percentage of all modified microblades) show significant differences among Groups A1, A2, and B (χ^2=11.03, df=2, p=0.004). The pie charts in Figures 10.28 and 10.29 show higher percentages of laterally modified microblades in Group A1, with about equal representation of lateral and end modified microblades in Groups A2 and B.

The differences examined above may relate to the differential extent of deletion of medial segments, therefore proximal width was examined for any patterning among the groups (see Table 10.7 and Figures 10.29-10.30). The groups were significantly different in proximal width (F=11.498, df=1354, p=0.000), and PLSD tests showed that B microblades had smaller widths than all other groups (mean difference of –2.5 to 2.7 mm), and Group A2 had larger widths than Groups A1 and B (mean difference of +2.5-2.7 mm). Figure 10.31 shows that Group A1 has a more peaked proximal width distribution, whereas the other groups a more platykurtic. Groups A2 and B are similar in their distributions, with a relatively normal distribution, whereas Group A3 is skewed to the right (larger width values). This suggests A1 microblades reflect narrower selection criteria for width than the others and that Groups A2 and B are similar in the production of a wider range of microblades with different widths. ANOVAs of microblade group differences in proximal width using only complete and proximal segments produced substantially identical results (F=11.19, df=636, p=0.000).

Microblade core parts are present in all of the groups, but are predominant in Group B, which has 1 microblade core, 1 core fragment, 13 core tablets, and 3 facet rejuvenation flakes.

Tools are generally found in all four groups, especially burin spalls and modified flakes, which may contribute to a toolkit relating to producing microblades and perhaps composite tools.

A number of generalizations can be made about these microblade groups and a model is presented to explain the observed patterning. Group A1 is clearly the most divergent group in most of the variables examined. The microblades in Group A1 clusters are made on principally exotic material types, occur in small numbers, have relatively high frequencies of laterally modification, are dominated by medial segments, and show a very peaked width distribution. All of these data are consistent with an interpretation of these microblade clusters resulting from removal of damaged lateral insets within composite tools and discard on site. Group A1 microblades were likely manufactured offsite.

Groups A2, A3, and B are somewhat more difficult to interpret, given the uncertainty about how microblades were used in a systemic context. Groups A2 and B are more similar to each other in certain characteristics than either are to Group A3. These similarities include predominance of local lithic raw materials, percent of modified microblades (8% vs. 0%), similar percentages of end and laterally modified microblades, and flat normal proximal width distributions. However, there are notable differences between Groups A2 and B. Group A2 microblade clusters have low total numbers of microblades, and are represented by more complete microblades and less medial segments. In terms of segmentation representation, Group A2 is more similar to Group A3. Both Groups A2 and A3 have depressed medial segment frequencies, suggesting preferential removal of medial segments. The primary difference between Group A2 and A3 is that some modified microblades are found within the former, and none within the latter. Group A3 is different from Group A2 in that the former is composed of both local and exotic raw materials and has a skewed width distribution whereas the latter is composed of primarily local raw materials and a more normal width distribution.

A tentative model that might explain these patterns is that Group A2 and A3 microblades were the result of microblade manufacture where a considerable number of microblades were removed from the site within composite tools. Group B microblades may represent manufacturing loci where a relatively large number of microblades were produced, and about 10% of them were subsequently used for various tasks in each location as well as for composite tool manufacture or maintenance and subsequent removal from the site. Group A2 microblade clusters represent manufacturing loci similar to Group B, but either (a) used at less intensity, (b) used for a shorter period of time, or (c) represent a different microblade production mode, reflecting the production of fewer microblades suitable for insets.

Other aspects of microblade technological organization may be inferred from these patterns. The presence of microblade cores and core parts may relate more to the *intensity* of microblade production rather than *different types* of microblade production (i.e., production of microblades for specific tasks requiring specific morphologies). The regularity in numbers of microblades in Groups A1, A2, and B may relate to specific modes of microblade production and inset replacement. The ratio of microblades per unmodified flake is relatively similar for each group, between 0.28 and 0.36. This may suggest that there are limited differences in terms of flake quantity among various microblade production / inset removal and discard, and other related tasks. The limited variability in microblade quantity, segmentation, percent of laterally modified microblades, and proximal width within Group B clusters (which represent 74% of all microblades found in Components 2 and 3) suggests that microblade production was a very standardized process.

The spatial patterning of these microblade groups for Component 3 is illustrated in Figure 10.32. Group A1 microblade clusters are found in Subareas B1, B2, B4, C2, C3, and D1, and absent in Area A and Subareas B3, C1, C4, and D2. The spatial patterning of Groups A1 and B suggest that they are functionally related. Almost all Group A1 clusters are surrounded by a Group B cluster, whereas Groups A2 and A3 clusters are found both with the Group A1/B areas and outside them (e.g., Subareas C1 and D2). This may relate to the differences between Group B and Groups A2 and A3; the former may specifically reflect production of microblades for the immediate consumption (i.e., inset replacement), the latter may be more related to production of insets for new composite implements. This may explain the higher degree of medial segment deletion in Groups A2 and A3 (present at 23-25% vs. 37% for Group B). Groups A2 and A3 are generally segregated from Group A1, further differentiating them from the latter.

The large microblade production clusters (Group B) were found isolated as single clusters within each Subarea, except for Subarea C2-C4, where CmC1 and CmR1 are found interspersed. It is interesting that this one location is also where radiocarbon data and three-dimensional back plots suggest more than one occupation may be present. Given that R1 is found only in the context of Groups A1, A2, and A3 in Areas B and D, it is possible that R1 in Area A may represent an earlier occupation, perhaps associated with hearth Feature 18, whereas C1 in Area A may represent the later occupation associated with Areas A, B, and D, and hearth Feature 12.

However, the density isopleth data (Figure 10.17) show a clear decrease in R1 lithics around Feature 12, which may indicate contemporaneity. Implications for site organization and site function are discussed below in the section on Subarea level analysis.

Table 10.6 Microblade cluster variable summary.

Group	*Cluster*	*Total items*	*Total MB*	*Modified MB (%)*	*End mod. %*	*Lateral mod. %*	*Comp.*	*Prox.*	*Medial*	*Distal*
A1	AmC7	3	3	1 (33)	33	-	33	0	67	0
A1	BmC3a	9	8	8 (100)	-	25	0	0	100	0
A1	BmC4b	55	1	1 (100)	-	100	0	0	100	0
A1	BmC4c	79	5	1 (20)	-	-	0	80	20	0
A1	BmC4d	31	3	2 (67)	-	67	0	33	67	0
A1	BmC7b	8	7	2 (29)	14	14	0	29	43	29
A1	BmO	18	17	8 (47)	-	6	0	0	94	6
A1	CmC7b	27	16	7 (44)	6	31	6	13	75	6
A1	CmJ1	5	4	1 (25)	-	-	25	25	50	0
A1	CmO	59	22	5 (23)	5	18	14	50	23	14
A1	DmR1	51	6	2 (33)	17	17	0	50	0	50
A1	EmCh2	42	3	3 (100)	-	100	0	0	100	0
A2	AmC4	369	18	1 (6)	-	6	11	39	39	11
A2	BmR1a	15	13	1 (8)	-	8	0	62	15	23
A2	CmC3	13	13	1 (8)	-	8	8	23	54	15
A2	CmC4	67	29	3 (10)	3	7	3	35	31	31
A2	DmC4b	116	36	2 (6)	-	6	8	47	22	22
A2	EmC1	50	37	3 (8)	3	-	30	32	8	30
A2	EmCh1	368	64	6 (9)	5	2	8	52	27	14
A3	AmC1	5	2	0	-	-	0	50	0	50
A3	BmC3b	3	3	0	-	-	0	0	67	33
A3	BmC7a	7	2	0	-	-	50	50	0	0
A3	BmR1b	9	3	0	-	-	0	67	0	33
A3	CmAna	100	8	0	-	-	13	50	13	25
A3	CmC7a	154	42	0	-	-	0	38	21	41
A3	CmC9	50	11	0	-	-	9	9	36	46
B	AmAr	433	196	21 (11)	2	6	0	40	39	21
B	BmC1a	315	134	18 (13)	3	6	2	39	44	16
B	BmC1b	1097	215	18 (8)	5	4	5	41	34	20
B	CmC1	775	170	14 (8)	3	2	3	42	39	17
B	CmR1	353	170	9 (5)	1	3	1	42	41	17
B	DmC1a	1121	180	7 (4)	2	2	3	46	26	25

Table 10.7 Microblade group variable summary (counts and averages).

Group	*pW (mm)*	*Avg. Total Items*	*Avg. Total MB*	*Modified MB (%)*	*End mod. %*	*Lateral mod. %*	*Comp. %*	*Prox. %*	*Medial %*	*Distal %*
A1	11.1±5.8	32	8	43	20	80	6	25	58	11
A2	13.5±8.0	143	30	8	38	62	11	43	25	21
A3	13.4±5.9	47	10	0	0	0	4	35	23	38
B	10.8±6.0	682	178	8	40	60	2	42	37	19

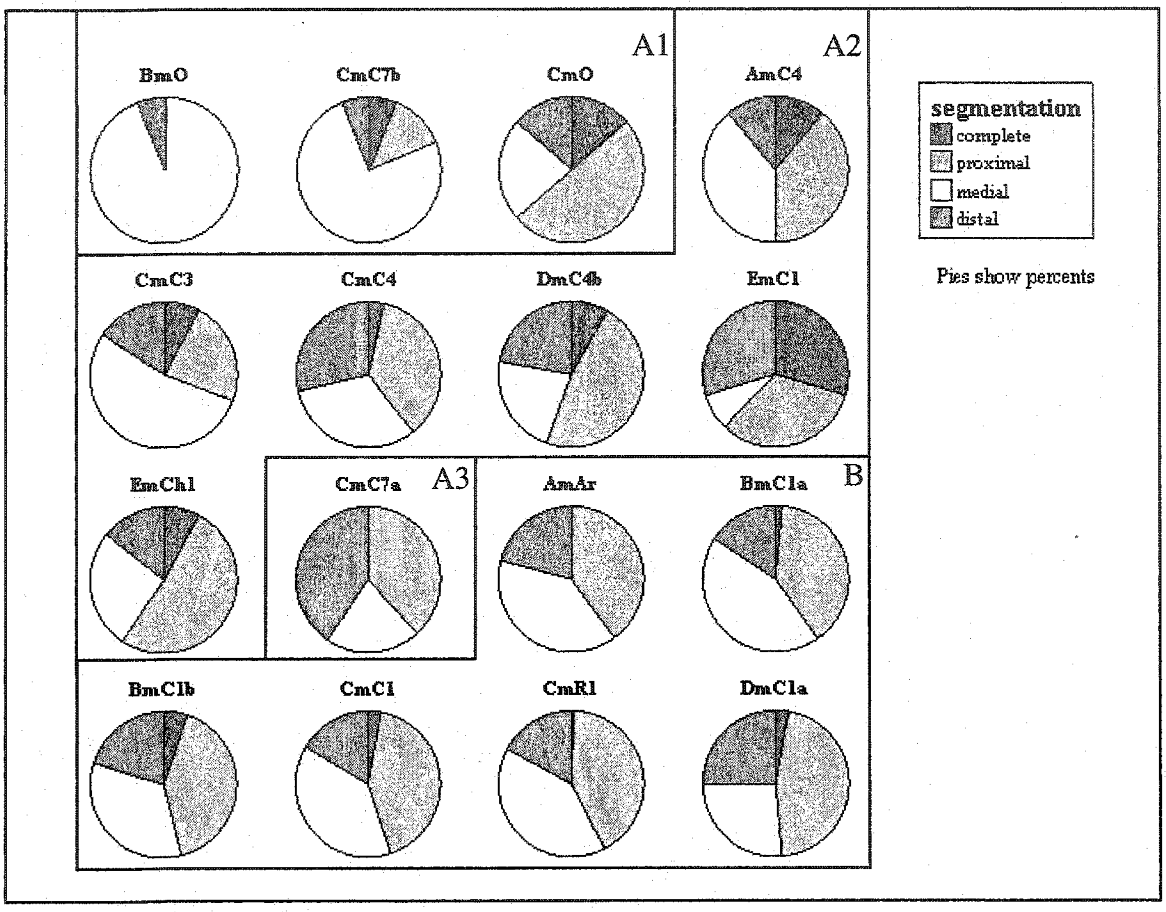


Figure 10.26 Segmentation distribution among microblade clusters.

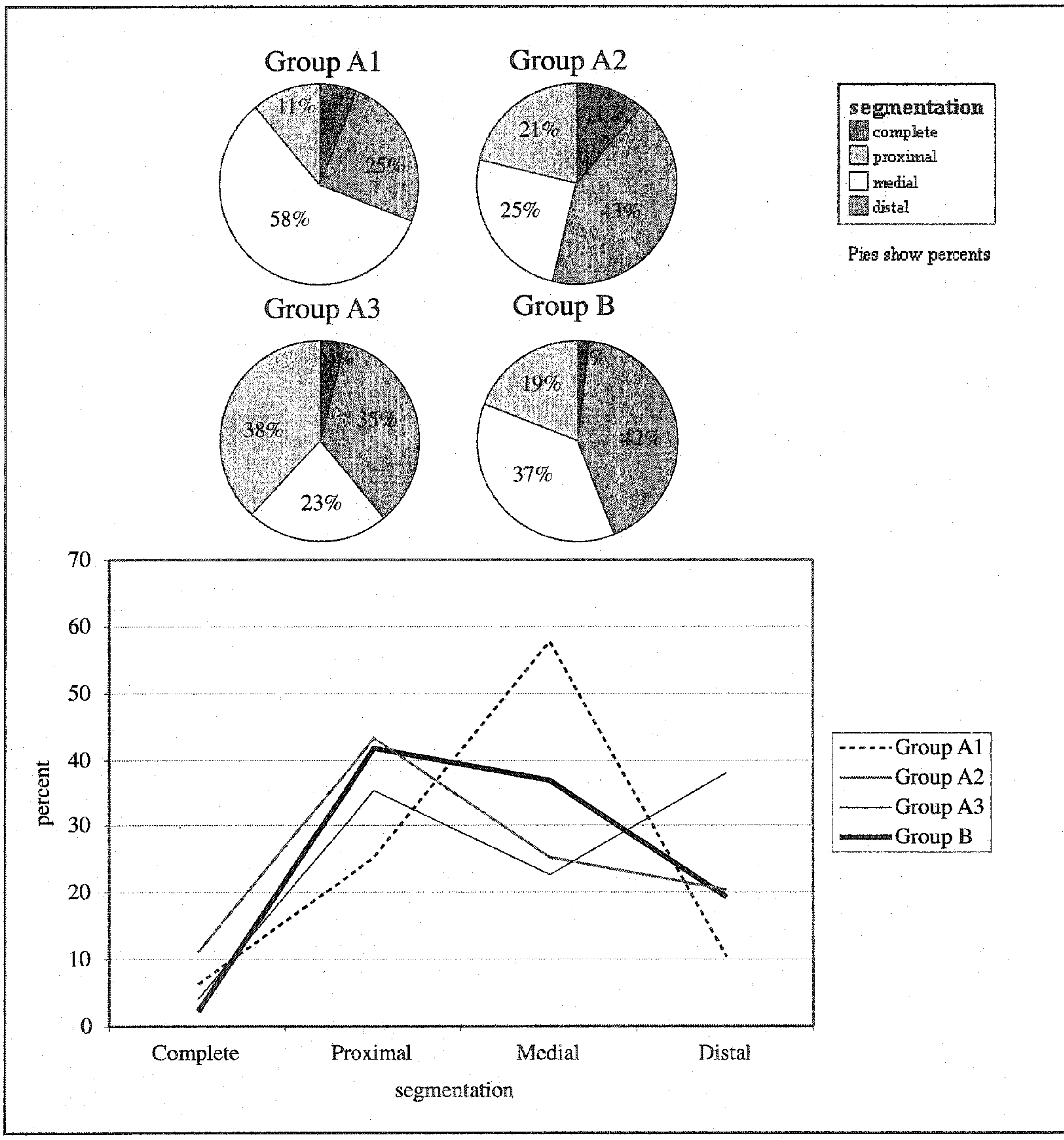


Figure 10.27 Segmentation distribution among microblade groups.

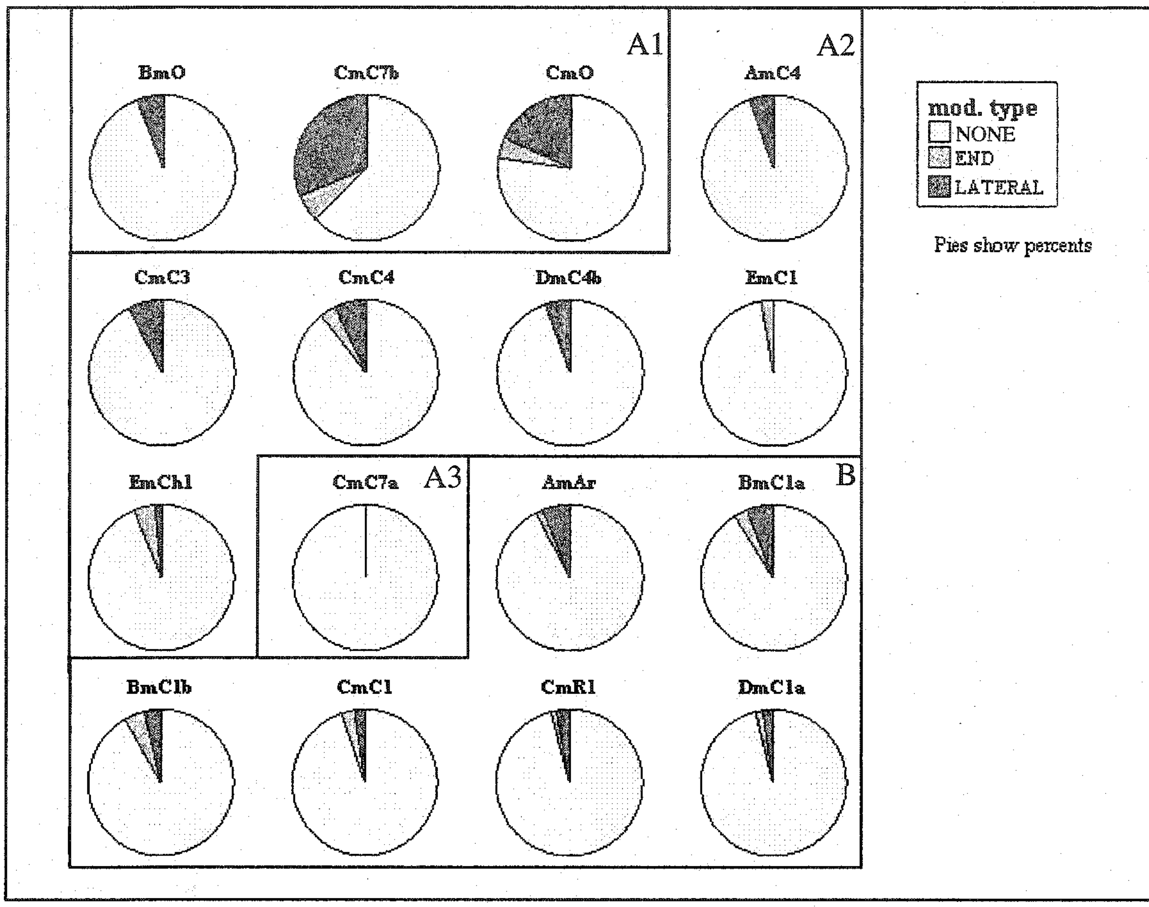


Figure 10.28 Microblade modification types among microblade clusters.

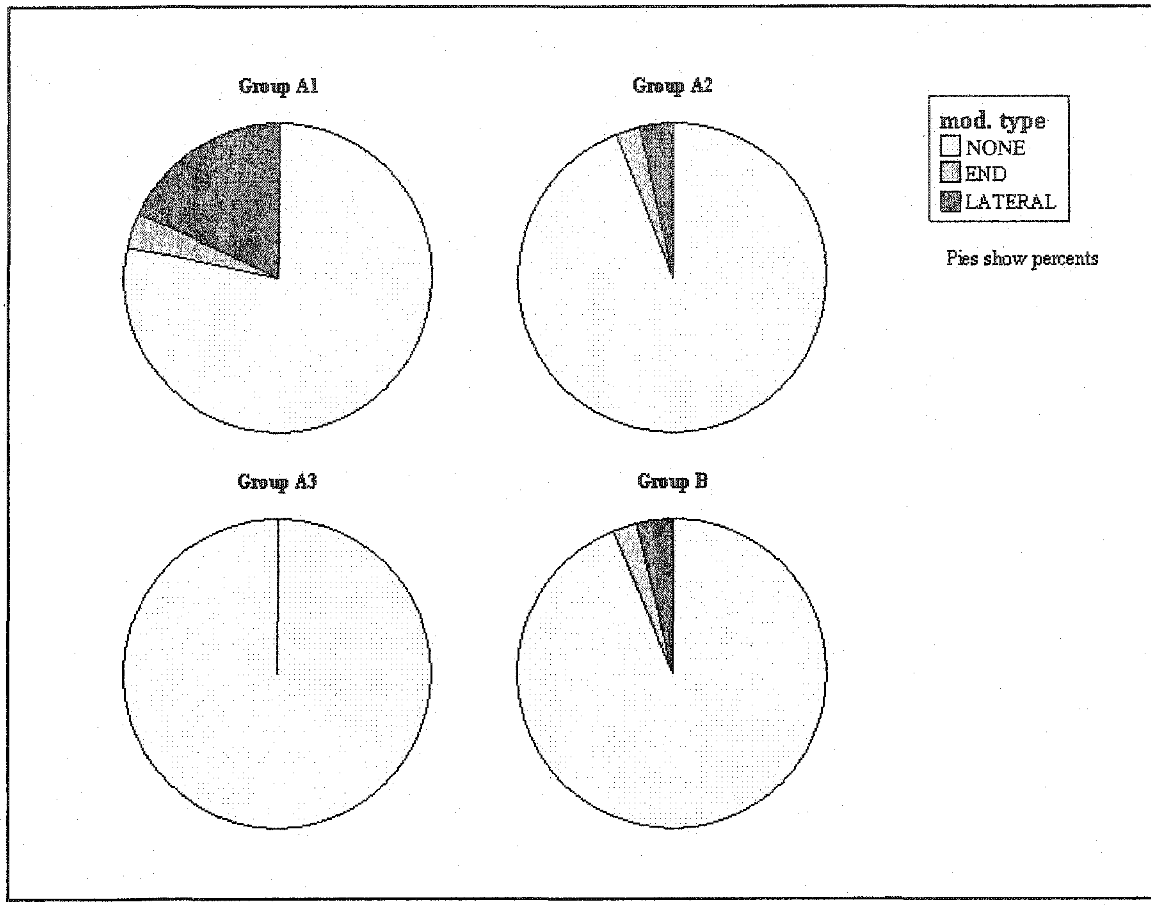


Figure 10.29 Microblade modification types among microblade groups.

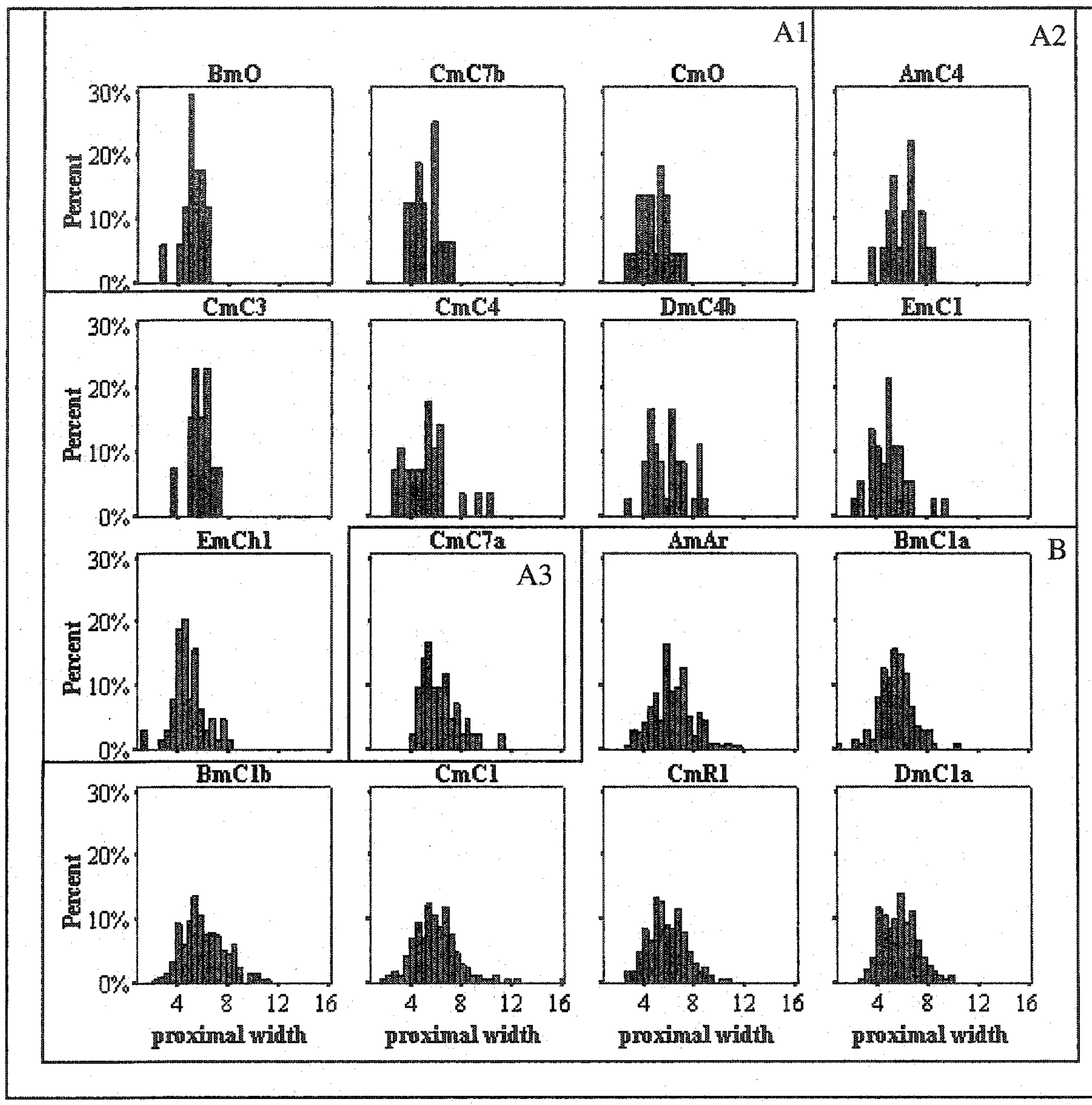


Figure 10.30 Proximal width histograms among microblade clusters.

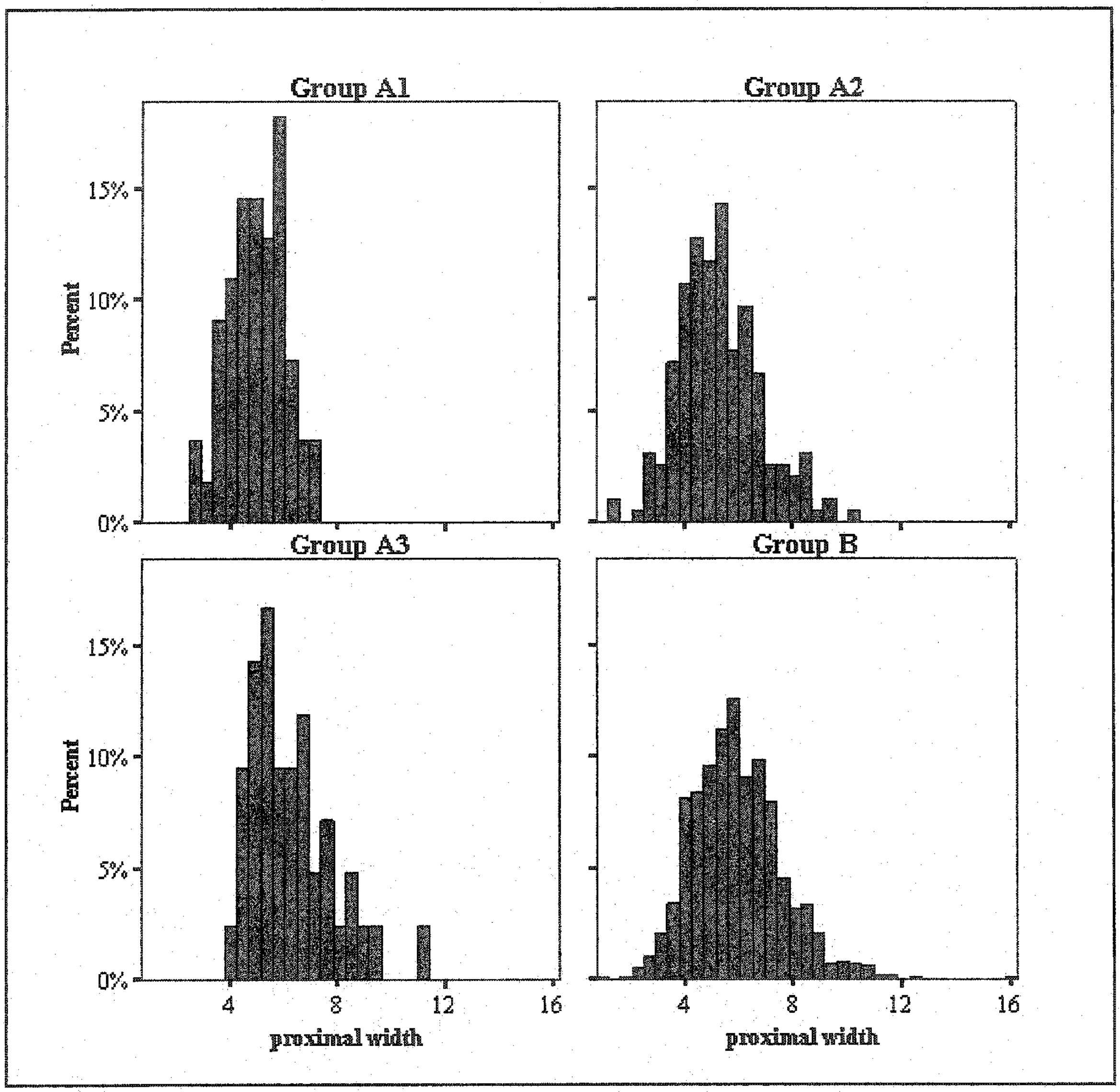


Figure 10.31 Proximal width histograms among microblade groups.

Figure 10.32 Spatial distribution of Component 3 microblade clusters by group .

Non-Microblade Clusters

Given the relative number and abundance of non-microblade lithic clusters, which comprise 36% of the total items, and 42% of the total unmodified flakes (by number) other tasks were common at these components. Components 1, 4, and 5 have no microblade clusters. Non-microblade clusters comprise 28% of Component 2 (by weight) and 21% of Component 3 (by weight), sizeable fractions. Tools found within these clusters and associated on the basis of material type show some covariation. Bifaces are the only tools found more often in non-microblade clusters. Burins, burin spalls, beveled flakes, and modified flakes are all more common in microblade clusters than in non-microblade clusters (χ^2=18.191, df=5, p=0.002).

Formal tools, tool fragments, or cores were not found with the non-microblade clusters, with the exception of a biface in DmR2a and a burin spall and beveled flake in FmC1, and two bifaces and a burin spall in KmC5 (in Component 1). A few modified flakes were found associated in non-microblade clusters, but much fewer than in microblade clusters. These patterns suggest that non-microblade clusters reflect locations where formal tools were resharpened or maintained and carried away for further use. The presence of bifacial thinning flakes in non-microblade clusters in the morphological debitage analysis indicates that these formal tools included bifaces (see Chapter 8). Demarcating which clusters relate to bifacial or unifacial tool maintenance or resharpening cannot be done without more detailed debitage analyses.

In order to identify differences in debitage between microblade and non-microblade clusters, size class percentages of unmodified flakes were compared (Figure 10.33). Non-microblade clusters have generally smaller flakes, with fewer size class 2 and 3 flakes (69% vs. 80%) and more size class 1 flakes (26% vs. 15%) (χ^2=190.65, df=8, p=0.000). No bifacial or unifacial preforms were found. These patterns suggest that the non-microblade clusters represent relatively minor resharpening or other maintenance of already formed tools.

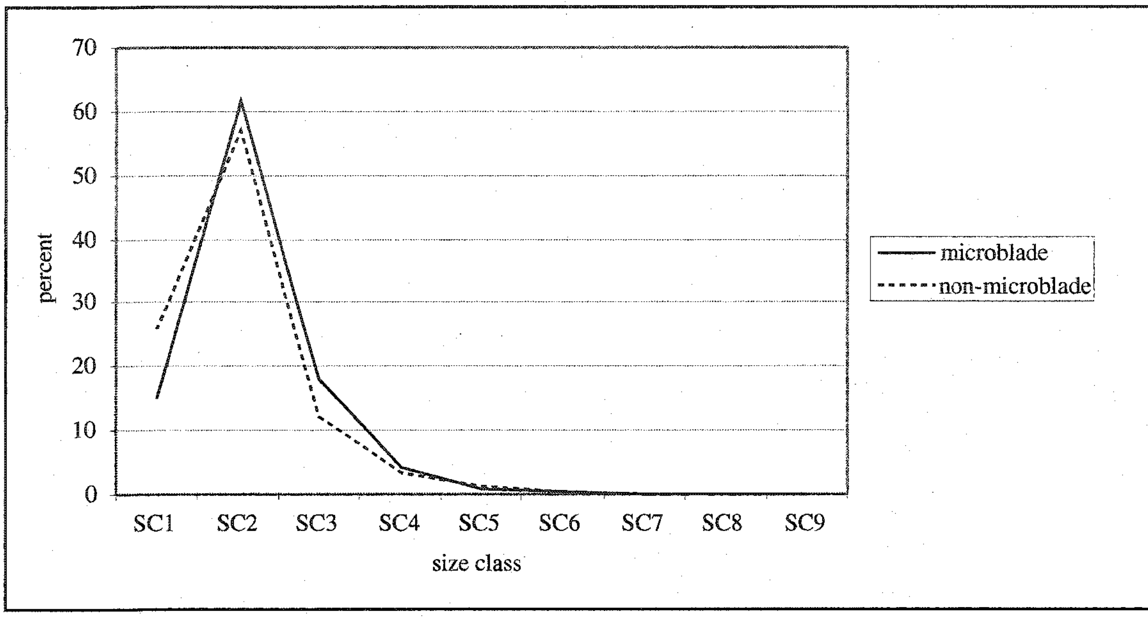


Figure 10.33 Microblade and non-microblade cluster flake size class distributions.

Subarea and Area Level Analysis

General Spatial Patterns

Spatial patterning of lithic tools and debitage are organized in depositional sets in such a way as to suggest the reflection of activity sets. The tight correspondence between tool clusters and debitage clusters suggests that analysis on tool cluster content and inference of activity tasks performed with each cluster may be warranted. If a more random arrangement was seen, or if numerous formal tool types were present, such an analysis could be confounded by effects relating discard/abandonment of tools further from their place of manufacture/maintenance or last use.

Use areas appear to be internally homogeneous with respect to microblade production, however, there are some differences with respect to non-microblade tool clustering. Non-microblade tools cluster in a few areas within Component 3, notably tool clusters TB2 and TD (see below). The presence of a number of non-microblade lithic concentration loci in other areas suggests that patterns in tool deposition are not equivalent with tool activity areas. However, the spatial analysis when coupled with debitage data and information about technological organization (see Chapter 7) can be used to isolate non-microblade tool use areas. Even within the microblade concentrations, some spatial patterning exists among microblade core parts and modified and unmodified microblades. Within Subarea B2, the microblade production area (near Feature 5) is located about one meter to the east of a number of core parts. Within Subareas C1 and C2, microblades and core parts are located in the same areas as used and unused microblade concentrations. Thus, depositional sets can be reasonably linked with activity sets on the basis of the independent datasets described above.

These depositional sets were likely formed through three processes, the first relating to expedient tool manufacture on flakes and blades of the same material type as debitage clusters within the subareas. Many of these tools were possibly manufactured at those locations, used for a short time (given the limited intensity of retouch), and discarded within the same location. The second process relates to tool maintenance and discard (and possible use) of both expedient and formal tools on local and exotic raw materials likely manufactured off-site. The third process relates to tool maintenance where the tool was not discarded, but curated for later use and taken off the site, or at least out of the area where resharpening flakes are present.

The borders of the depositional sets are relatively distinct, though there is some ambiguity in Subareas C2, C3, and C4. A reasonable hypothesis, based on lithic refits, is that Subareas C2 and C3 are linked as one activity area, characterized by microblade production and use in Subarea C2 and modified flake use in Subarea C3. There does not appear to be patterns of reuse of areas, and microblade and non-microblade tools are generally spatially segregated.

Recurrent clusters of tool types can be defined, indicating multiple tasks were performed in various portions of Component 3. While the definition of these recurring types cannot be considered *a priori* to reflect activity sets, they nonetheless form regular patterns within the site, and can at least be considered as depositional sets.

Artifact classes seem to be constrained by hearth features. Most tools (and debitage) are situated within 25-150 cm of each hearth centroid, with very few beyond this area, coinciding with drop zones around the hearths. No heat alteration was observed in Component 3 microblades or debitage, and the spatial patterns of lithics suggest deposition was constrained by the location of hearth features. The tool cluster with the highest amount of tool diversity (TB2) is also the only one located further than 1 m from a hearth, in an area with relatively few faunal fragments, suggesting that a specific activity area not related to butchery is represented. This tool cluster also is unique with the absence of boulder spall scrapers. Boulder spall scrapers tend to be located at the periphery of tool clusters near faunal clusters, indicating a more direct spatial relationship with fauna.

The inter-hearth distance in Component 3 is regularly spaced, with an average of 2.1±0.8 m between each hearth and its closest neighbor. None of the hearths have properties relating to a focal hearth such as significantly greater size, depth, or presence of distinctive tool classes. All are of the same size and general morphology, though there is variation in faunal remains directly within each hearth (see Chapter 9). The regularity in inter-hearth distance in Component 3 may indicate a contemporaneous occupation by multiple social units.

The depositional sets overlapped to some extent, on the basis of microblade and non-microblade debitage clusters, refits/conjoins, and distribution and diversity of tool clusters. However, with the integration of various datasets, specific loci of depositional and activity sets were isolated (see above). The activity areas defined below on the basis of tool and debitage clusters are generally similar sizes and shapes, generally circular, with a diameter of 2-3 meters, generally located on one side of one or more hearths. They are spaced systematically, at about 2-3 m apart, with the exception of Subareas C2-C4, which are separated by a smaller distance, ~50 cm.

No arcs of debris identified by the presence of sharp borders of cultural material are present at Gerstle River that would indicate tent structures or other structures that could influence artifact or faunal patterning by walls, etc. The areas with few lithic artifacts or faunal are interpreted to have been the result of discard behavior rather than areas where items were cleared. The primary explication of the spatial patterning in lithics and fauna relate to drop and toss zones of associated hearths and the faunal spatial functional model developed in Chapter 6. The areas devoid of cultural material are generally associated with a slope of about 10°, compared to a nearly level occupation area in Areas A, B, C, and D (see Figure 4.22).

Variation in Lithic Raw Material Use

Numbers of material types varied among clusters, ranging from 1 (Area G) to 14 (Subarea C3), averaging 6.4 material types per cluster. Evenness values (SDI) for Component 3 subareas range from Subarea B4 (SDI=0.679) as the most uneven to Subarea C3 (SDI=0.930) as the most even. The other Component 3 subareas have SDI values between 0.834 and 0.918, indicating relatively even distribution of artifacts per material type. This reinforces the hypothesis that the primary technological pattern was maintenance of tools and cores brought to the site.

The issue of contemporaneity of these components is difficult to address with material type data. The lithic reduction sequence in Component 3, limited to microblade production (which was shown to occur in spatially restricted locations, see above) and tool maintenance as well as the limited number of refits and the small size of the debitage suggest that the deposition of lithic raw material types is primarily constrained by the tools maintained at a particular place rather than use by a particular occupation.

In order to identify patterns in the array of material types present within each Component 3 lithic subarea, hierarchical cluster analysis was conducted. Ward's method and the binary squared euclidean measure were used on presence/absence matrices of all material types. Figure 10.34 shows that the most divergent subareas were C2, C3, and C4, likely the result of the high number of material types (averaging 12.3 vs. 6.5 for the other subareas and areas). Area A and Subareas B3 and C1 were clustered, with presence of Ar and C7, but B3 and C1 appear more similar with presence of C9 and R1 and absence of An and O. Subareas D1, D2, and B4 are similar with presence of C1, C4, and R2 and absence of R1 (except in Subarea D1). Subareas B1 and B2 were also relatively similar with presence of C1, C3, C4, R2, and S. There are no modes of lithic raw material type use, such as groups of subareas with principally one material type or a small array of types. This further suggests that local raw materials were not abundant or high quality.

Tool Distribution

A number of site structural and technological organizational issues relate to the spatial distribution of tools across a site, including relation to lithic concentrations, spatial segregation, and tool co-occurrence. Figures 10.35 and 10.36 show tool and microblade core-related debitage (cores, core tablets, etc.) distributions in Component 3. Tool distributions within Components 2 and 4 are illustrated in Figures 9.2, 9.5, and 9.44.

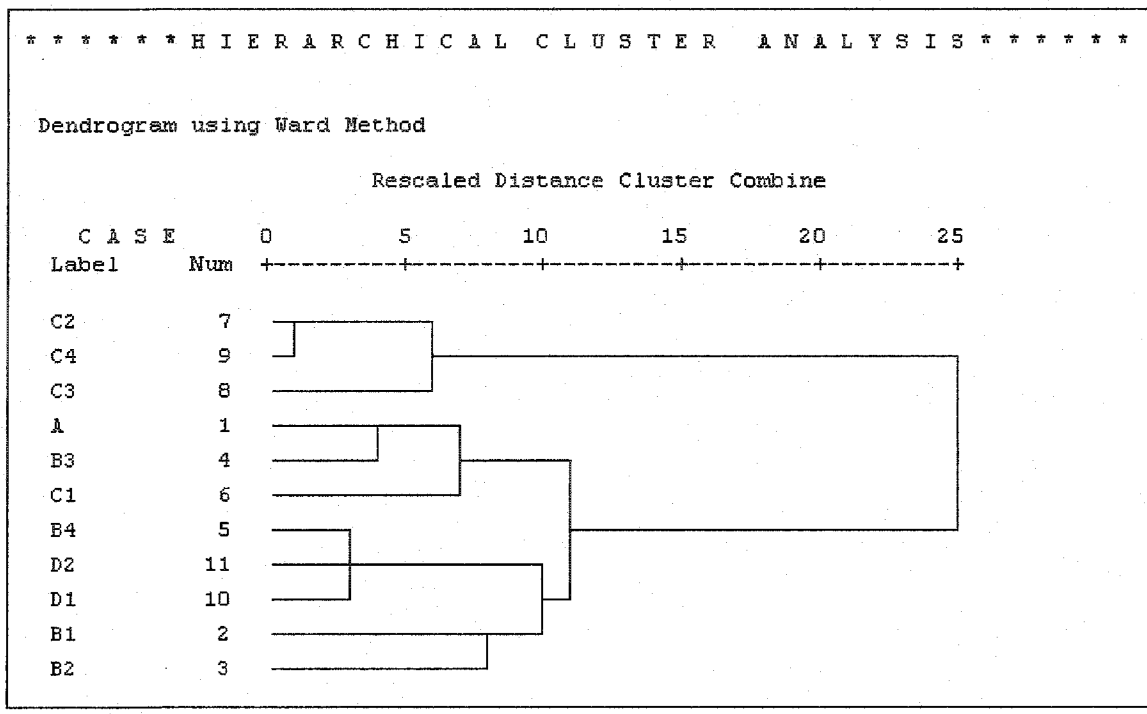


Figure 10.34 Hierarchical cluster analysis of lithic material types for each Component 3 lithic subarea.

Relationship to Lithic Concentrations

Most tool classes are located directly within the debitage concentration areas, further indicating these areas are the locations for activity areas that include tool maintenance and tool use rather than simply lithic reduction loci. Modified microblades, microblade core tablets, facet rejuvenation flakes, and core fragments are situated directly within microblade production areas. As discussed above, microblade cores tend to be at the outer edges of microblade production areas. Only two bifaces were found, both within flake clusters of their own material type. Burin spalls are generally found near modified microblades within lithic concentration area and are not spatially associated with burins. Beveled flakes are generally found within lithic concentration areas. Modified flakes are generally found clustered together within the lithic concentration areas. One of the tool classes, however, has a different distribution. Boulder spall scrapers are also found at the periphery of the lithic concentration areas at the interface between faunal and lithic clusters. These spatial relationships indicate that boulder spall scrapers may have been used in dismemberment and early processing near faunal cluster F5. This may further suggest that another faunal concentration area may be located to the north of Area C, where three boulder spalls have been recovered.

Spatial Distribution

Four tool clusters comprised of two or more tool classes can be described on the basis of spatial distributions in Component 3, each associated with a lithic concentration area, and are designated TA, TB, TC, and TD to distinguish them from the debitage concentration areas and subareas (TA within Area A, etc.). The tools are less widely dispersed than the debitage and microblades, and each tool cluster is situated within the bounds of the associated debitage concentration area. These tool clusters are more associated with the microblade clusters than with the non-microblade clusters (compare Figures 10.35-10.36 with Figure 10.25). The refitting analysis indicates that further subdivision of tool clusters is possible. Three areas of tool concentration can be defined within TB, one located to the northeast of Feature 1 (TB1), one located about 1.5 meters northwest of Feature 3 (TB2), and one located between Features 3 and 5 (TB3). Two areas can be defined for within TC, one to the west and north of Feature 12 (TC1), and another to the east of Feature 12 (TC2). Summary data on each tool cluster is provided in Table 10.8. Tool clusters within other components are localized and are listed as TE within Area E, TF within Area F, TH within Area H, and TK within Area K. Area G had only one tool and Area H had no tools.

Tool Co-Occurrence

Total number of tools, formal (non-microblade or burin spall), expedient (modified flakes and boulder spall scrapers), and tool descriptions for each tool cluster are listed in Table 10.8. On the basis of the Component 3 tool spatial distributions, three tool assemblages can be defined, one relating to microblade production and inset replacement, the other relating to modified and beveled flakes, and the third relating to boulder spall scrapers.

Microblade production areas (defined by presence of microblades and microblade core parts) are generally near but not directly within the modified flake groups or the boulder spall scraper groups. The modified flake groups are generally separated from the microblade groups but still within the main lithic concentration areas. The boulder spall scraper group tends to be located on the periphery of the lithic concentration areas and are more closely associated with faunal clusters. Assuming tool deposition is directly related to tool use, it is reasonable to hypothesize areas of microblade production, composite point repair/inset replacement, non-microblade tool resharpening/use, and faunal processing areas.

On the basis of summary data presented in Table 10.8, tool clusters are described in relation to potential activity sets. More specific details on microblade use variability are provided in the next section. TA reflects microblade production/use and perhaps composite implement manufacture. TB1 reflects microblade production/use and bifacial and unifacial tool use and maintenance (on the basis of debitage characteristics). TB2 reflects a non-microblade activity area with unifacial tool use and maintenance. The presence of a number of microblade core parts (core frag, core tablets, facet rejuvenation flake) in TB2, with few microblades is interesting, and may reflect two stages of core reduction or preparation and microblade production. TB3 reflects microblade production. TC1 reflects both microblade production and use in the southern portion and use of modified flakes in the northern portion. TC2 reflects microblade production and modified flake use. A number of tools are located singly outside of the tool clusters defined above, including a burin, convergent side scraper, boulder spall scrapers and modified flakes. Faunal processing, if associated with modified flakes and boulder spall scrapers, is reflected in TB1, TB3, and at the peripheries of TB1, TB2, TB3, and TC1.

Several large cobble manuports (including a large chopper/spall core) that could have been used as platforms or anvils for processing faunal material were located at the periphery or outside of the lithic concentrations and are spatially more associated with the faunal clusters (Figure 10.35). Four large cobbles surround faunal cluster F5 and may have been used to butcher the carcass segments (see Figure 6.45).

Table 10.8 Tool cluster summary data.

Tool Cluster	N tools	Formal (non-MB, or BS)	Expedient	Tools[6]
TA	27	1	2	1 BU, 1 FRF, 2 MF[7] (1B, 1C), 4 end MMB, 13 lateral MMB
TB1	48	0	7	6 BS, 2 FRF, 6 MF (1B, 4C, 1D), 4 end MMB, 11 lateral MMB, 1 BSS
TB2	24	2	8	3 BS, 1 ES, 1 FRF, 1 MBCORE FRAG, 5 MBCT, 7 MF (3 B, 4 C), 4 lateral MMB, 1 SS, 1 BSS
TB3	25	1	4	1 BIF, 4 BS, 2 FRF, 1 MBCT, 1 MF (1C), 9 end MMB, 7 lateral MMB, 3 BSS
TC1	69	0	29	11 BS, 1 FRF, 4 MBCT, 24 MF (2A, 5B, 13C, 1D), 8 end MMB, 15 lateral MMB, 5 BSS
TC2	30	0	14	4 BS, 1 MBCT, 13 MF (1A, 2B, 7C), 2 end MMB, 6 lateral MMB, 1 BSS
TD	36	3	13	1 BIF, 2 BS, 2 ES, 1 ESFRAG, 2 MBC, 2 MBCOREFRAG, 3 MBCT, 12 MF (1A, 3B, 6C, 2D), 4 end MMB, 7 lateral MMB, 1 BSS
TE	30	0	6	7 BS, 3 FRF, 6 MBCT, 1 MF, 4 end MMB, 5 lateral MMB
TF	4	1	3	1 BS, 1 ES, 2 MF, 1 BSS
TH	9	1	8	1 BU, 8 MF
TK	6	2	3	2 BIF, 1 BS, 3 MF

Variation in Microblade Production

The distribution of clusters of microblade groups developed above is spatially patterned. Table 10.9 lists the total microblades and number of microblade clusters for each microblade group within each subarea. Subarea B4 is not included as only one modified microblade was located there. Areas A, B, and D contained only one Group B cluster, whereas Area C contained two clusters per subarea, C1 and R1. Given the relative homogeneity of the microblade technological spatial distributions (see above), this may indicate two occupations in Area C.

There is a negative relationship between number of microblades within each cluster and number of clusters within each subarea, i.e. the more microblades are present, the fewer clusters they reflect. This is particularly apparent with Group A1, with an average of 1.7 clusters per subarea vs. 0.8 clusters per subarea for the other groups. Group A1 averages 9 microblades per subarea, Group A2 averages 30, Group A3 averages 10, and Group B averages 151. These frequencies are consistent with the interpretation offered above for each group.

[6] Tool descriptions do not include microblades with minor lateral or dorsal damage, but these are included in the N tools column.
[7] Modified flakes are subdivided into Types A, B, C, and D (from Chapter 7).

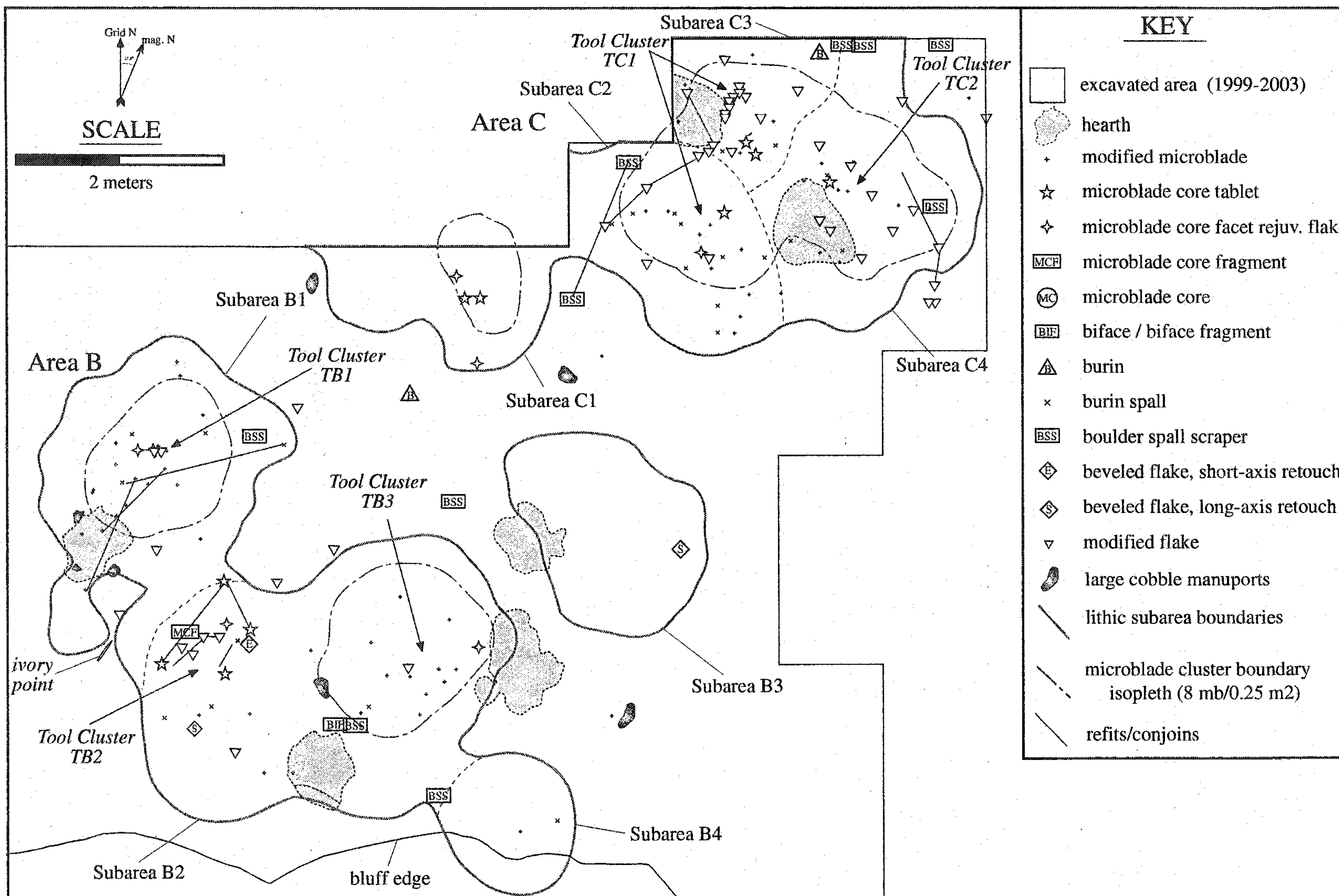


Figure 10.35 Component 3 tool distribution, Areas B and C.

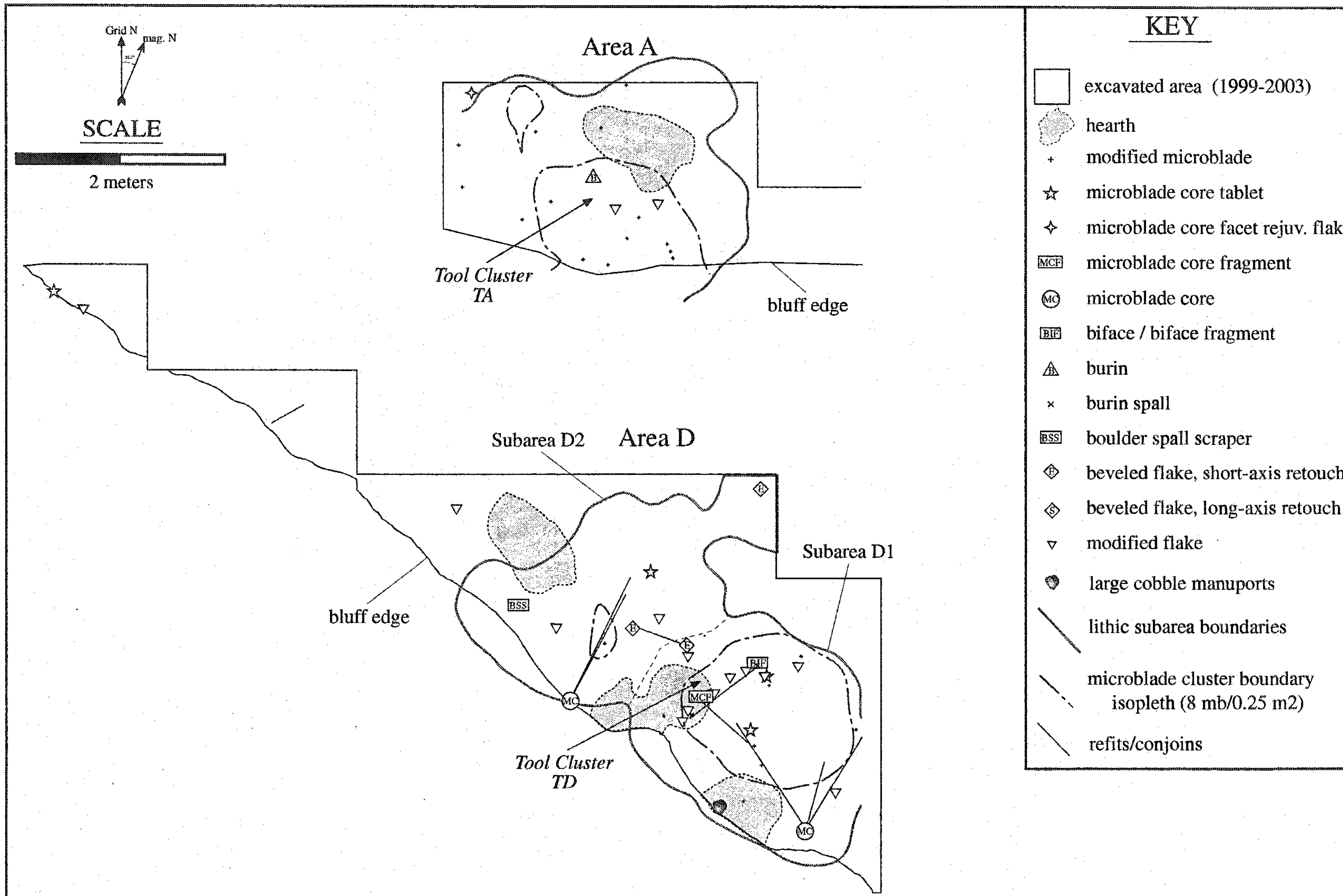


Figure 10.36 Component 3 tool distribution, Areas A and D.

Segmentation representation among Subareas is compared in Figure 10.37. Subareas A, B1, B2, C2, C3, and C4 all have relatively high percentages of medial segments, whereas Subareas C1, D2, E, and to a lesser extent, D1 have lower percentages of medial segments. The latter subareas (except C1) contain larger relative amounts of microblade cores and core fragments. Subareas C1, D2, and Area E are unique in that they are not dominated by Group B microblade production clusters. This pattern may be a signature of a specific type of microblade production, characterized by relatively small numbers of microblades (13-64), deletion of medial segments, and microblade core discards.

Modification type percentages for each subarea are illustrated in Figure 10.38. Subareas A, B1, C2, C4, and D2 have high relative percentages of laterally modified microblades, whereas Subareas B2, C3, D1, and E have more even values of end modified and laterally modified microblades, suggesting inset discard and production for the former and use within an activity area for the latter.

With the interpretations offered above, the relative contribution of each microblade group per subarea can be used to estimate activities relating to microblade production, use, and discard (ordered by relative importance) (Table 10.10). Area A is characterized as microblade production and use of microblades within an activity area. Subarea B1 is characterized by removal and discard of insets, with lesser amounts of microblade production and use within the activity area. Subarea B2 is characterized by microblade production, with lesser occurrence of removal and discard of insets and use within the activity area (the last primarily situated in the eastern portion, near Feature 5). Subarea B3 is characterized by removal and discard of insets alone. Subarea C1 is characterized by microblade production alone with no use within an activity area. Subarea C2 is characterized by use of microblades within an activity area, and lesser occurrence of microblade production and removal and discard of insets. Subarea C3 is characterized by microblade production, use within an activity area, and removal and discard of insets. Subarea C4 is characterized by microblade production, with lesser occurrence of inset removal and discard and use within an activity area. Subareas D1, D2, and Area E are characterized by microblade production, with lesser occurrences of inset removal and discard and use within an activity area. Microblade production within Subareas D2 and E may be related to replacements of insets on-site, and within Subarea C1 may relate to production of new insets. Microblade production within Subareas A, B2, and C4 may relate to both production of new composite implements and replacement of used composite implements.

Table 10.9 Microblades and microblade clusters per group per subarea.

Subarea	*Group A1*	*Group A2*	*Group A3*	*Group B*
A	3 (1)	18 (1)	2 (1)	196 (1)
B1	26 (3)	-	-	134 (1)
B2	6 (2)	13 (1)	7 (3)	215 (1)
B3	7 (1)	-	1 (1)	-
C1	-	-	42 (1)	-
C2	14 (3)	19 (2)	4 (1)	83 (2)
C3	17 (3)	10 (1)	3 (1)	113 (2)
C4	9 (3)	13 (2)	12 (2)	139 (2)
D1	6 (1)	-	-	180 (1)
D2	-	36 (1)	-	-
E	3 (1)	101 (2)	-	-

Table 10.10 Inferred microblade activities per subarea.*

Subarea	*MB production*	*Inset removal and discard*	*Use in activity area*	*Inset replacement on-site (used composite implements)*	*Inset production (new composite implements)*
A	+	-	+	+	+
B1	-	+	-	-	0
B2	+	-	-	+	+
B3	0	+	0	-	0
C1	+	0	0	-	+
C2	-	-	+	+	-
C3	+	+	+	+	-
C4	+	-	-	+	+
D1	+	-	-	-	0
D2	+	0	0	+	0
E	+	-	-	+	0

*+ = greater evidence, - = lesser evidence, 0 = no evidence

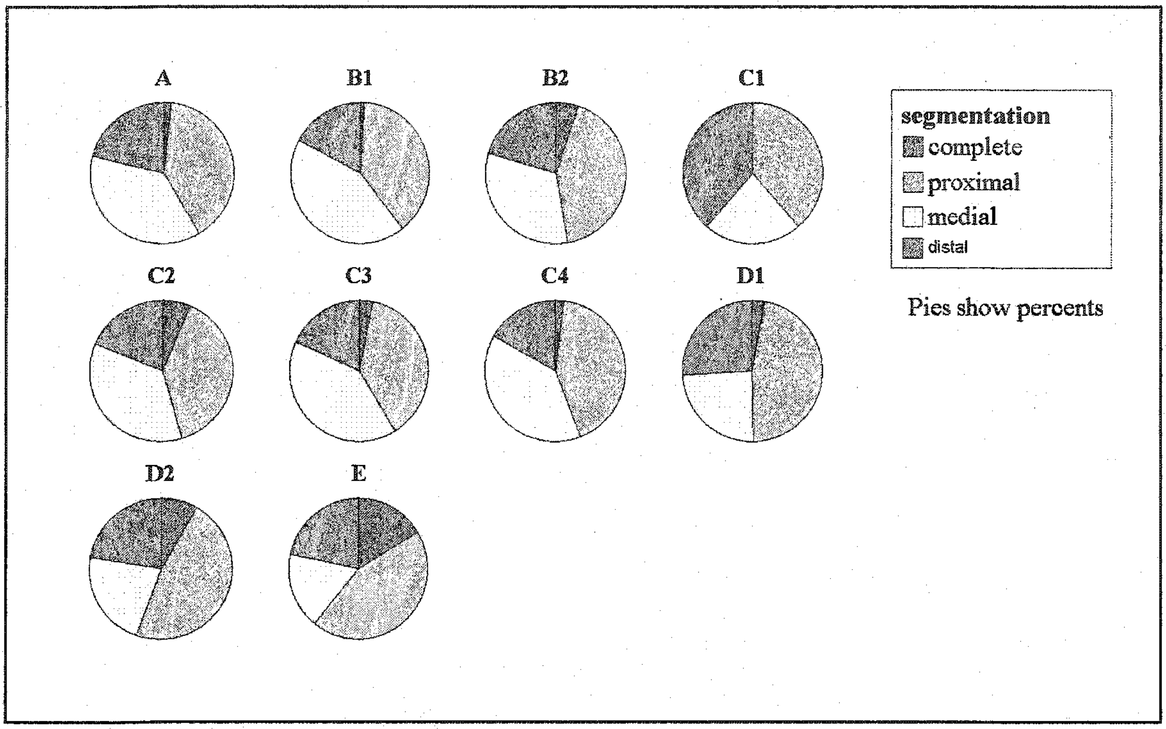


Figure 10.37 Segmentation representation per lithic subarea.

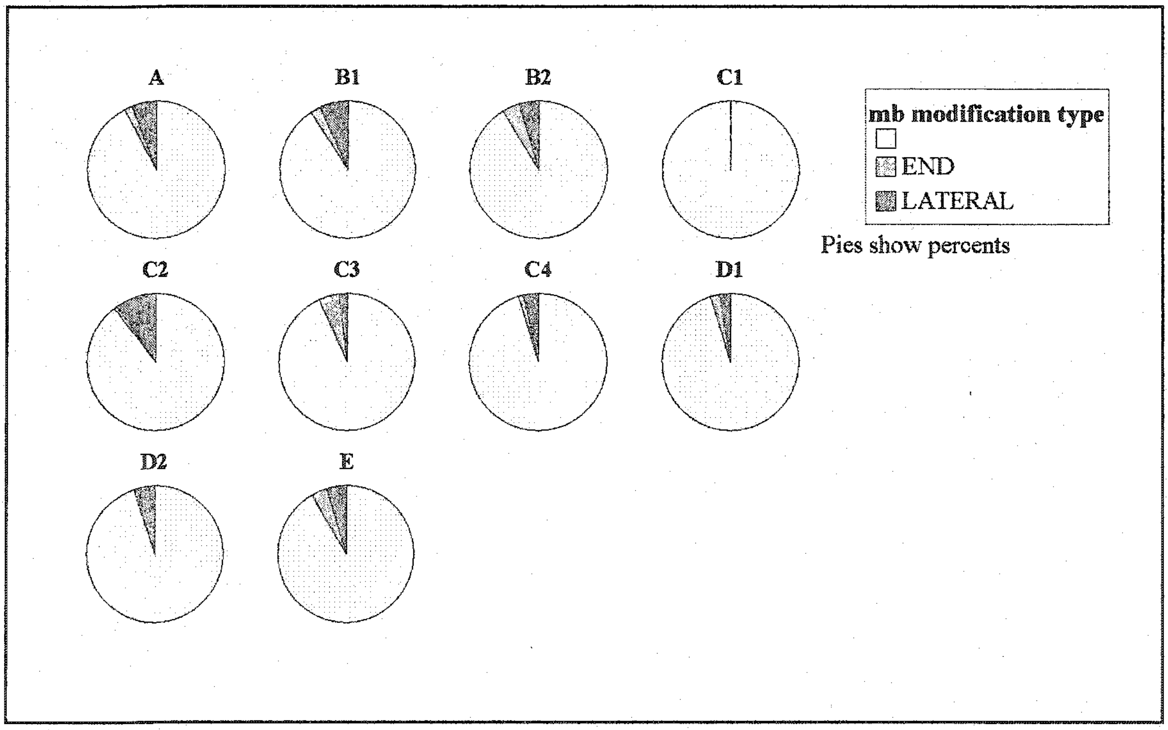


Figure 10.38 Microblade modification type per lithic subarea.

Feature Drop and Toss Zones

Expectations relating to spatial distribution of artifacts differ between indoor and outdoor hearths (Carr 1991; Stevenson 1991). Drop zones situated on one side of the hearth will be expected for outdoor hearths, as wind becomes a factor. Toss zones should not occur within structures. Finally, arcs of debris should be present against the outer edges of a structure. The data from Components 2, 3, and 4 hearths indicate that these were outdoor hearths not used in conjunction with tents or other portable shelters.

As described above, almost all of the lithics fall within drop zones of one or more hearths, and few debitage clusters fall outside this zone. Very little horizontal or vertical displacement was observed in Component 3, suggesting that a zone of displacement, intermediate between the drop and toss zones was not a major factor in artifact dispersal. The generally tiny size of resharpening flakes and microblade production related debitage would not hamper movement around the hearths. Faunal remains, on the other hand, may have been displaced in these zones. Faunal clusters that may have been affected by this type of displacement is the eastern portion of faunal cluster F4, the northwestern portion of cluster F6b, and the portion of cluster F9 between Features 13 and 14. Figure 10.39 illustrates the relationship between drop zones around hearths and lithic concentrations.

Void areas (or open areas), devoid of lithics or fauna, are generally found on one side of each feature. Features 1, 3, 9, 13, and 14 have void areas to the west. Features 5 and 12 have void areas to the southeast. Void areas for Features 10, 16, and 18 cannot be distinguished given truncated bluff edges or unexcavated areas. Feature 18 may have a void area to the north, and Feature 16 may have a void area at the southwest to southeast. The general similarities in void areas to the west may suggest contemporaneous occupation with the wind blowing from the east. Table 3.1 shows that the prevailing wind in the summer is from the west, whereas from September to April, it is from the east to east southeast. Given other seasonality indicators for a fall occupation in Component 3, these data are consistent with a prevailing wind from the east southeast. The differences in void areas for Features 5 and 12 could indicate they may relate to another occupation, perhaps occurring in the summer.

While it may seem presumptuous to define seating around hearths based on the distribution of lithic concentrations, the small debitage size and limited disturbance of small flake clusters make such an endeavor reasonable and instructive. Potential patterning in seating arrangements may suggest areas where multiple occupations may produce a palimpset of artifacts and debitage. The following seating models are developed on the basis of Figures 6.24, 10.25, 10.32, 10.35, and 10.36. Figure 10.39 shows a seating model where each discrete debitage concentration is assigned as one person. Multiple material types may be agglomerated under one person, and thus the overall number of persons seated around the hearths may be underestimated. Figure 10.40 shows a seating model based on Binford's outdoor men's hearth model taking into account clusters of different material types, and may be more consistent with the data. The purpose of this exercise is not to estimate site population, but rather to identify locations where multiple activity areas may overlap within the model shown in Figure 10.39. Feature 1 may be associated with one person to the northeast and one to the south. Feature 3 may be associated with one person to the northeast and one to the northwest. Feature 5 may be associated with one person to the west. Feature 9 may be associated with one person to the east. Feature 10 may be associated with one person to the south and one to the west. Feature 12 may be associated with one person to the east and one person to the west. Feature 13 may be associated with one person to the southeast. Feature 14 may be associated with one person to the east and perhaps one to the north. Feature 16 may be associated with one person to the north. Feature 18 may be associated with one person to the east. Within the model shown in Figure 10.40, three persons may be associated with Features 10, 1, 3, and 12, two persons may be associated with Features 5, 13, and 18, and one person may be associated with Features 14 and 16, though the truncation of the bluff edge may have removed materials to the southwest.

With these models, Subarea B1 and tool cluster TB1 are coherent and suggest a single occupation using Feature 1. Subarea B2 is associated with two hearths, Features 3 and 5. An area of potential conflation is identified between Features 3 and 5, coinciding with tool cluster TB2. Subarea B4 may be associated with Feature 5. Tool cluster TB2 is likely associated with Feature 3, and tool cluster TB2 may represent two activity areas. Subarea B3 is likely related to Feature 9. This is interesting, as microblades were generally absent in Subarea B3, and the cluster is rather isolated and small compared to the larger activity areas in Subareas B1 and B2 and C2-C4. Another area of potential conflation is apparent in Subarea C2. Two activity areas are apparent on the east and west sides of hearth Feature 12. The refitting analysis suggests that an activity area oriented to the north, toward Feature 18 may be present. This area coincides with tool cluster TC1. With the exception of these two areas, Subarea C2 and the eastern portion of

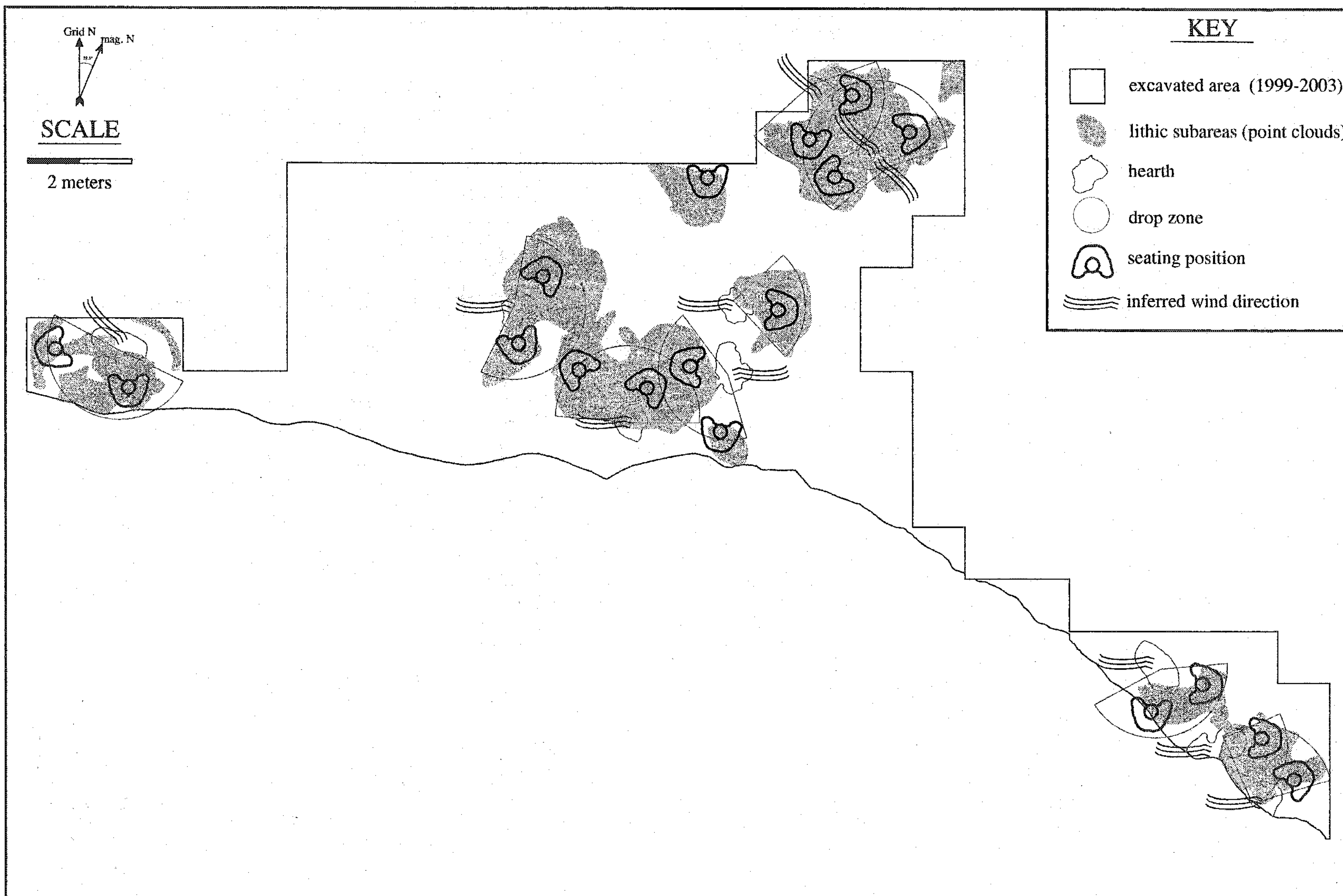


Figure 10.39 Component 3 exterior hearth seating plan model based on lithic concentrations.

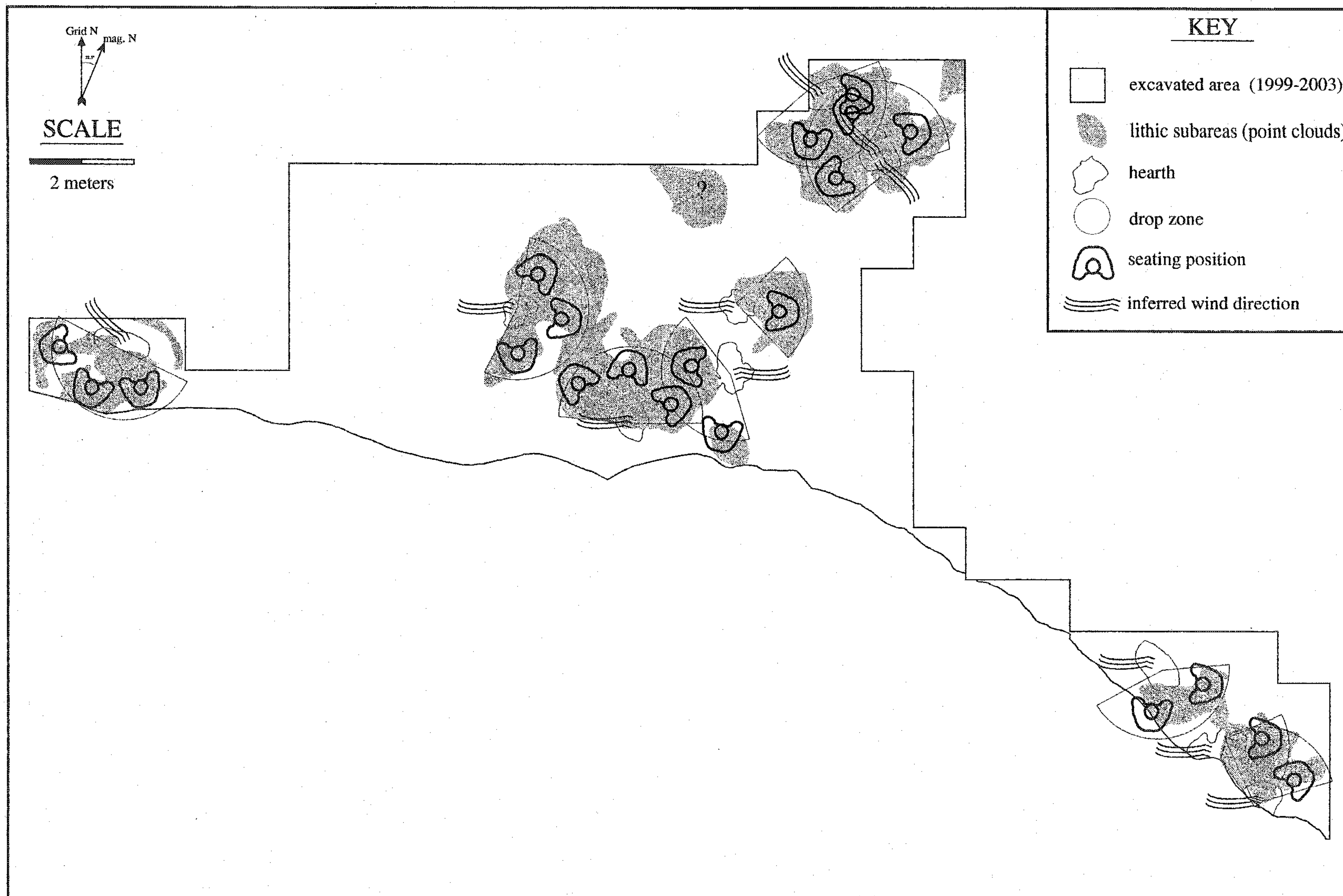


Figure 10.40 Component 3 exterior hearth seating plan model based on material type distributions.

Subarea B2, the remaining Component 3 lithic concentrations are consistent with the interpretation of a single occupation.

Spatial Association Among Lithics and Faunal Remains

Spatial relationships between fauna and lithics may take three general forms, (1) random (i.e., no association), (2) positive (lithics and fauna co-occur in space), and (3) negative (lithics and fauna are segregated). In order to determine the spatial relationship between faunal remains and lithic items within Component 3, a correlation analysis was conducted between number of total lithics and faunal weight, and number of lithics and number of faunal fragments within each excavated quadrant. Of a total of 388 quads excavated, 103 (27% of total) did not contain either lithic items or faunal remains, and were eliminated from the analysis. The remaining 286 quads were analyzed through Pearson's correlation coefficient (r) (see Figure 10.41). Number of lithics and faunal weight were not correlated, with $r=0.001$, $p=0.000$. Lithics and number of faunal fragments were weakly positively correlated, with $r=0.236$, $p=0.000$. The low correlation coefficient values suggests that there is no relationship between lithics and faunal weights and a weak positive relationship between lithics and number of faunal fragments per $0.25m^2$ quad. An explanation is that the more highly fragmented faunal remains are associated with processing areas within lithic concentrations. Figure 10.41 reveals a negative curvilinear, concave upward relationship between lithics and fauna abundance per quad, suggesting general segregation of faunal and lithic areas within Component 3. This supports the hypothesis that the lithic clusters and faunal clusters reflect organization of space within the site during Component 3 occupation.

The spatial distribution of faunal and lithic concentrations is shown in Figure 10.42. This map will form a basis for the descriptions and interpretations provided in the next section. There is close correspondence between faunal cluster F1 and Area A, faunal cluster F3 and Subarea B1, faunal cluster F4 and Subareas B2 and B4, faunal cluster F6b and Subareas C2, C3, and C4, and faunal cluster 9 and Area D. While faunal clusters F5 and F6a are not directly associated with a lithic concentration, they are present on the periphery.

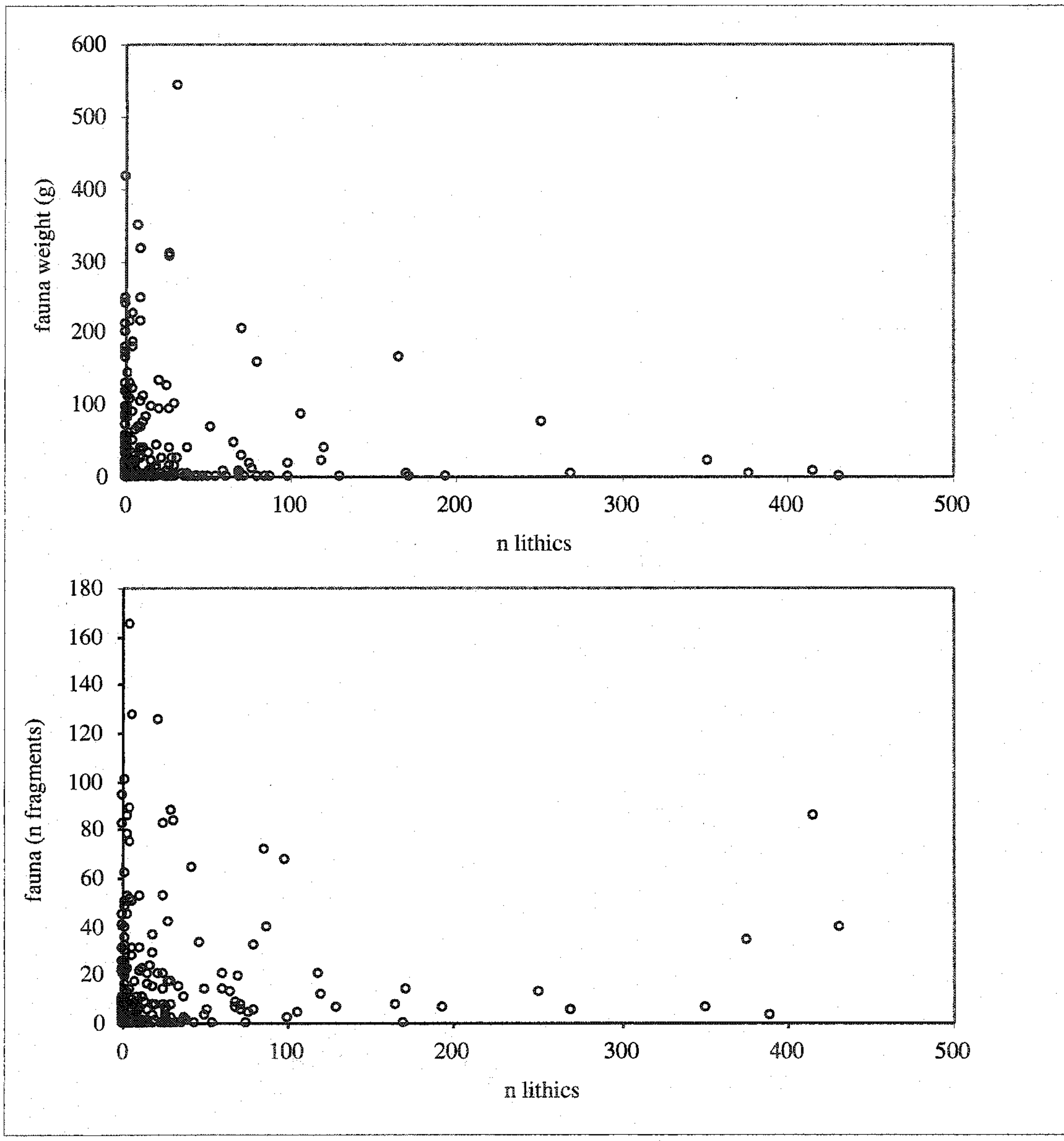


Figure 10.41 Scatterplot of number of lithic items by faunal weight and number of fragments per $0.25m^2$ quads.

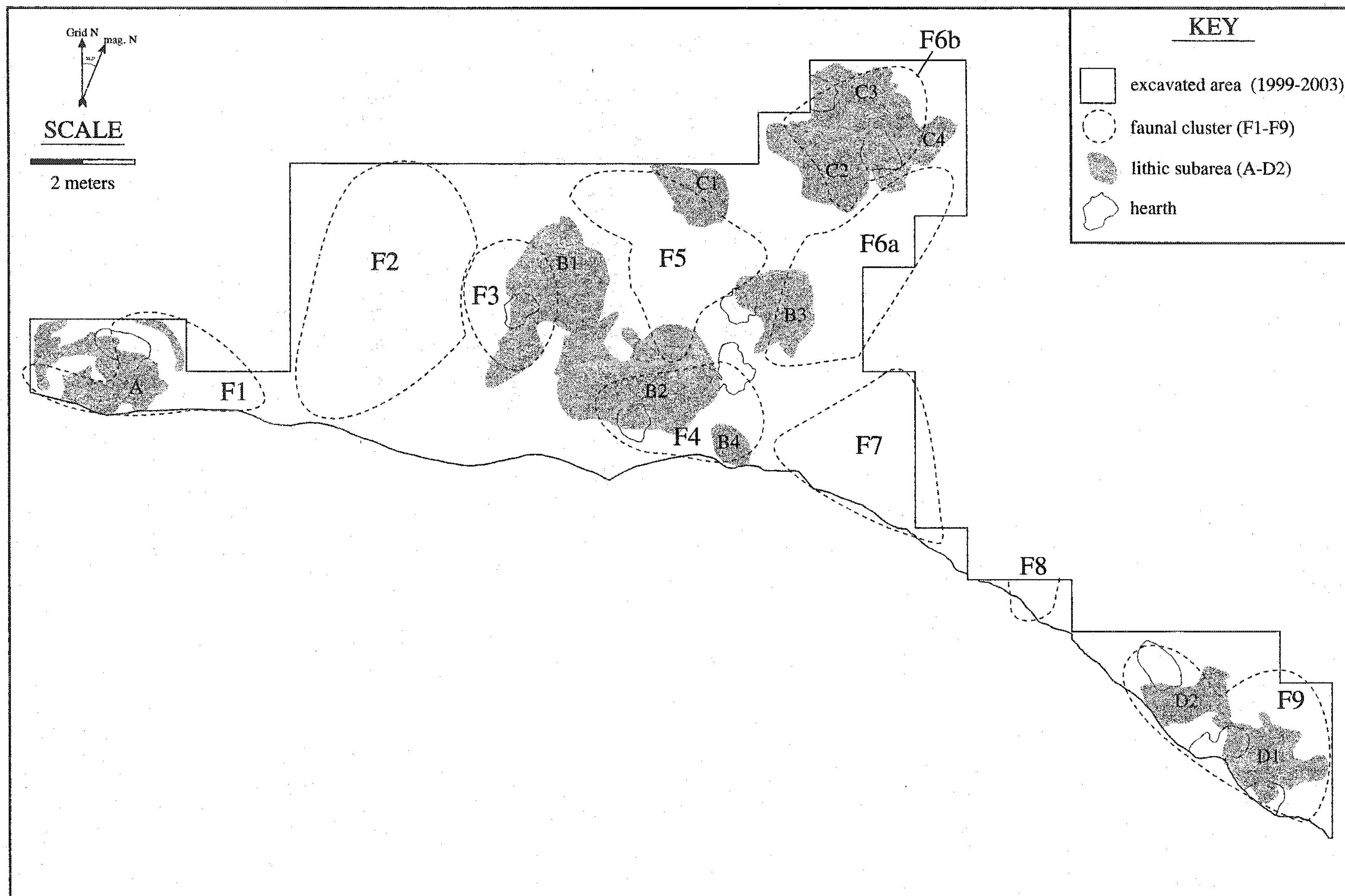


Figure 10.42 Spatial relationship of Component 3 faunal and lithic concentrations.

Area Description and Interpretation of Spatial Organization

This section integrates the data, patterns, and analyses provided in Chapters 5, 6, 7, 8, and 9. While the context of this discussion is interpretation of the lithic areas and subareas within Components 1 through 5, data on faunal processing, technological organization, variation in the microblade industry, and specific artifact descriptions are included. Dimensions of variability described for each area include spatial organization, relation of lithic subareas to features and associated radiocarbon dates, cultural material abundance and diversity, hypothetical area activities, variation in microblade use, technological organization, and relationships to faunal remains. Inferences are regarding estimated number of flaking events based on material types, time of occupation, potential for reuse, and potential for disturbance from post-occupational factors. Inferences at the level of component, including nature and number of occupations, are provided in the next section.

Area A

Area A is characterized as an area of lithic concentration measuring 2.9 m east to west and 1.9 m north to south (grid orientation). One hearth is directly associated with Area A, Feature 10, dating to 8910±40 BP (β-167399). There are no obvious subdivisions of the lithic items, though there is a separation of the two major material types, Ar to the south of Feature 10 and C4 to the north and northwest of Feature 10. There were no refits found in this area. A total of 811 lithic items were found in Area A, 589 flakes, 219 microblades (23 are modified), two modified flakes, and one burin. The burin is of exotic material (C6), and was likely curated and possibly used in this area, as no C6 flakes were found in the area. The modified flakes include one Type B and one Type C, both with moderate damage. Both were made of Ar, and were likely selected, used, and discarded in a short period of time. The total amount of lithic material is 65.41 g, with a weight density of 11 g/m^2, about average for Component 3 areas and subareas. Clusters associated with microblades make up 100% of Area A materials by weight, and given the low diversity in tool types, microblade production and use were the primary tasks in this area.

Area A contained one Group B microblade cluster (89% of total Area A microblades), and 23 microblades from three Group A microblade clusters. Segmentation distribution and modification types suggest microblade production and use in a variety of contexts, including use on location in an activity area, on-site inset repair, and inset production. Inset removal and discard is considered minimal given the relative lack of laterally modified microblades of exotic materials. The lack of complete microblades could be due to higher occurrences of snapping blades to produce medial segments.

Area A may be one of the more pristine examples of microblade production and use without non-microblade related tools that may obfuscate the spatial distribution of tools. No burin spalls, bifaces, unifaces, or boulder spall scrapers were found, and only two modified flakes were present. This may indicate that burins and microblades together form a specific toolkit, as has been suggested by Guthrie (1983b) and others. However, the broken faunal remains show very similar patterns of processing to faunal remains at Areas B and D, suggesting that other tools may have been present to the south of Area A, but have eroded out between 1995 and 1999. Faunal cluster F1 is directly associated with Area A, most similar to faunal clusters F3 and F4 associated with Subareas B1 and B2 (see Chapter 6). Inferred activities involve marrow processing, characterized by low %shaft weight, and relatively high %long bone weight. Fragmentation was somewhat lower in cluster F1 than in other processing clusters. Both wapiti and bison element portions were present in this cluster, spatially separated by about 2 m, with an MNI of two animals. Either of these clusters, or both may be associated with the lithics in Area A.

The number of flaking events can be estimated at four based on the material types (excluding the one burin, which had no associated debitage). Area A likely represents a short-term single occupation given the lithic debris density and small number of material types. The lack of material Ar in the other Component 3 areas could suggest a separate occupation. Potential for reuse is considered low, but potential for post-depositional disturbance is moderate, given the organic rich staining to the south of Feature 10, perhaps resulting from post-occupational scattering of charcoal fragments from the hearth.

Area B

Area B is characterized as an area of lithic concentrations measuring 6.3 meters east to west and 5 m north to south (grid orientation). Four subareas can be delineated on the basis of lithic concentrations, Subareas B1-B4. Within Subarea B2, two areas can be identified, one associated with tools and microblade core parts between Features 1 and 3 (associated with tool cluster TB2) and the other associated with numerous microblades near Feature 5 (associated with tool cluster TB3). The overall shape of Area B is an elongated "U," with the central void space filled with large articulated faunal remains, faunal cluster F5, representing a staging area where butchery and other tasks likely occurred. Faunal cluster F3 is centered on Subarea B1, F4 is centered on Subarea B2, and both represent bone marrow processing areas. Two other faunal clusters are situated west of Subarea B1 (F2) and east of Subarea B4 (F7), and these may represent toss zones/bone dumps where faunal remains were disposed, with F2 dispersed and F7 more aggregated. Faunal cluster F6a is found to the east and northeast of Subarea B3 and may reflect multiple types of activities, but the portion of F6a in Area B probably represents a disposal area (see Chapter 6). The faunal and lithic clusters are clearly patterned relative to each other (see Figure 10.42), and there are no large void spaces within Area B.

Four hearths are directly associated with Area B, Feature 1 (8860±70 BP, β-133750) in Subarea B1, Feature 3 (8950±40 BP, β-167395) and Feature 5 (8890±40 BP, β-167397) in Subarea B2, and Feature 9 (9030±70 BP, AA-51254) in Subarea B3. All four hearths are contemporaneous (see Chapter 5). Critical issues in Area B are assessing the possibility of contemporaneity among subareas, integrity of each subarea, and correlation of each hearth feature with associated lithic clusters. These issues are examined for each subarea and hearth.

Subarea B1 is situated primarily on one side of Feature 1, with a few items on the opposite side. No other hearth is within 3 m of this subarea, and the spatial pattern suggests that Subarea B1 represents a single occupation associated with Feature 1. Subarea B2 is the largest subarea within Area B, measuring 3 x 2 m. Two concentrations are present (described above), the eastern one is likely related to Feature 5, though it is situated near Feature 3 as well. Since the area to the south of Area 3 has eroded, it is difficult to establish whether the lithic concentration is associated with Feature 3, Feature 5, or both. Assuming that no lithic concentrations were present south of Feature 3, the eastern concentration (tool cluster TB3) may be associated with Feature 5 and the western concentration (tool cluster TB2) may be associated with both Feature 3 and Feature 5 (see Figures 10.39 and 10.40). If Features 3 and 5 are contemporaneous (consistent with the radiocarbon dating), then Subarea B2 likely represents a single occupation. Certainly, the lack of clearing debris, especially large faunal remains found in clusters F4 and F5, suggests that reoccupation was unlikely. Subareas B3 and B4 are relatively small in dimension (2.0 and 0.5 m^2 respectively) and self-contained with relatively few material types (7 and 3 respectively). These two subareas can reasonably be inferred to be the product of a single occupation each. Subarea

B3 is almost certainly associated with Feature 9, given the partial overlap and the lack of any other lithic concentration located closer to Feature 9. Subarea B4 is located about 1.5-2.0 m from any hearth feature, though it may have been associated with a now eroded feature to the south.

Refits throughout Area B suggest internal coherence within each subarea, or in the case of Subarea B2, within each cluster. This is consistent with small, localized tool maintenance and microblade production loci. Given this interpretation, discussion focuses on each subarea with respect to function.

A total of 2657 lithic items were found within Area B, including 2197 flakes, 417 microblades (60 are modified), 10 cores and core parts, 1 biface, 15 burin spalls, 1 short axis beveled flake (blade), 2 long axis beveled flakes, 14 modified flakes, and 4 boulder spall scrapers. The modified flakes include 4 Type B, 9 Type C, and 1 Type D, and were only found in Subareas B1 and B2. All but three of the modified flakes were made of local gray or black chert, the remainder were on rare materials for Area B (siltstone and gray rhyolite). The lack of flakes of these lithologies suggests curation of some of the modified flakes. The total amount of lithic material for Area B is 272.23 g, with a weight density of 11 g/m^2, average for Component 3 areas. Clusters associated with microblades make up 67% of Area B as a whole by weight, but the subareas are very different, Subarea B2 with 96%, Subarea B1 with 39%, and Subareas B3 and B4 with 7% and 0% respectively. The lack of formal tools in Subarea B1 along with the greater amount of non-microblade debitage suggests maintenance/use of unifaces and bifaces that were subsequently removed from the area. These patterns indicate that a wider variety of tasks took place in Area B relative to Areas A and C. Subareas B1, B3, and B4 reflect primarily bifacial and unifacial tool maintenance and perhaps use, whereas Subarea B2 reflects microblade production and use.

Area B contained two Group B clusters of 349 microblades, one in each major subarea (85% of total Area B microblades), 39 microblades from six Group A1 clusters, and 21 microblades from five Group A2 and A3 clusters. Segmentation distribution and modification types (Figures 10.36-10.37) suggest microblade production, inset replacement (used composite implements), and inset production (new composite implements) in Subarea B2 and inset removal and discard in Subareas B1 and to a lesser extent in Subarea B3. There is little evidence of inset production in Subareas B1 and B3. Microblade use within an activity area is possible for Subarea B2; while Subarea B1 contains more laterally modified microblades, Subarea B2 contains similar quantities of end and laterally modified microblades.

The delineation of activity sets within Area B is discussed above. There are three spatial clusters of tools (TB1, TB2, and TB3), each corresponding to a lithic concentration, though TB2 has much fewer associated flakes. The spatial relationships among the three, their relationships to the hearths and fauna, and differences in tool class co-occurrence suggests that these areas were used at the same time for a variety of tasks, including marrow extraction, microblade production and use, unifacial and bifacial tool maintenance, and possibly organic tool manufacture or maintenance. Evidence for the latter comes from the mammoth ivory point south of Feature 1, near tool cluster TB2.

Faunal clusters F3 and F4 are directly associated with Area B, and are very similar to clusters F1, F6b, and F9. Inferred activities involve marrow processing of long bones, though F3 is somewhat different in that a lumbar vertebral column was found at the edge of Feature 1, and a scattering of enamel and tooth fragments was located at the eastern edge of Subarea B1. Faunal debris from cluster F3 was discarded in a "toss zone" to the west and downslope (cluster F2), and faunal debris from cluster F4 were discarded to the east (cluster F7). Both wapiti and bison element portions were present in Area B, with an MNI of two to three animals in each cluster.

The number of flaking events can be estimated at 23 based on the material types (where n>3), eight in Subarea B1, nine in Subarea B2, five in Subarea B3, and one in Subarea B4. Area B likely represents one or possibly two short-term occupations given the lithic debris density, large number of material types, and position of hearths and lithic concentrations. Potential for reuse is considered moderate to low, and potential for post-depositional disturbance is low. Given the seating model above, the area of greatest likelihood for a palimpset of two occupations is tool cluster TCB3, near Feature 5. All of the other features arrangements are consistent for an easterly to southeasterly wind except for Feature 5, which is oriented for a northwestern wind (see below).

Area C

Area C is characterized as an area of lithic concentration measuring 6.25 m east to west and 3.25 m north to south (grid orientation). Four subareas can be delineated on the basis of lithic concentrations, Subareas C1-C4. The overall shape of Area C is an elongated oval oriented northeast-southwest, with faunal remains present mainly to the south (faunal cluster F6a). A much smaller faunal cluster (F6b) is situated to the south and within Area C. Cluster F6b represents a marrow processing area similar to those associated with Areas A, B, and D, and cluster F6a likely represents a disposal area. The faunal and lithic remains are patterned relative to each other (see Figure 10.42), and there is a void space between Subareas C2 and B3.

Two hearths are associated with Area C, Feature 12 (8830±50 BP, β-181678) in Subarea C4 and Feature 18 (9080±50 BP, β-183108) in Subarea C3. Two charcoal scatters are situated in Subarea C1 (Feature 11 dated to 9130±70 BP, AA-51253) and Subarea C2 (Feature 8 dated to 9130±40 BP, β-167398). Features 8, 11, and 18 are contemporaneous, but none are contemporaneous with Feature 12, which is contemporaneous with the main Component 3 occupation (based on nine hearth dates from Areas A, B, and D). Critical issues in Area C are assessing the possibility and nature of an older occupation, associated with the slightly older features described above, and the relationship between Area C and Area B.

Subarea C1 is located about 2.0 meters away from both Subareas B1 and C2, however, the unexcavated area north of Subarea C1 may contain more material. This subarea was assigned to Area C because of the clear separation with Subarea B1 and the faunal cluster F5 separating them. The small size and limited number of material types suggests a single occupation for Subarea C1.

Subarea C2, C3, and C4 were divided based on a number of criteria (see above). A number of independent data point to Subarea C3 as representing a potential palimpset of two occupations, one associated with Feature 18, and one dating to about 100 years later, associated with Feature 12 and the main Component 3 occupation. Subarea C3 contains absolutely more lithic items and more tools than either Subarea C2 or C3 (Table 10.4). Total lithic weight, count density, and weight density are the greatest for Subarea C3, and the density values are the highest for all areas and subareas at the site, regardless of component (except for Subarea D1, which has two microblade cores and a biface skewing the total weight). Subareas C2 and C4 show similarities in material types distributions, whereas C3 is the most divergent. Subareas C2 and C4 have six lithic clusters in each, where Subarea C3 has twelve lithic clusters. The similarities of Subareas C2 and C4 are striking, including count density (81 and 112 vs. 283 items/m^2 for Subarea C3) and weight density (6 and 10 vs. 32 g/m^2). However, refits show a link between Subareas C2 and C3, where Subarea C4 is relatively self-contained.

Given the data presented above, lithic materials B, C6, C8, Ch2, D, O, S, and large portions of C1, C4, J, and R2 may be related to this earlier occupation. The later occupation may be delineated by the distribution of lithic materials An, C3, C7, C9, R1, and portions of C1, C4, J, and R2. Material type C1 especially has some variability, dark gray (N 4/0) with 5% light gray inclusions located only within Subarea C2. Further differentiation of gray chert might enable a finer resolution for separating the occupations. Without more detailed analysis, such as attempts to refit smaller flakes and chips, or further excavation to the northwest, it is difficult to further delineate these two occupations. The faunal assemblage and spatial data indicate that this earlier occupation probably did not have a major role in forming the assemblage, as few faunal remains were found in this area. The presence of five boulder spall scrapers (two refit) in this area indicates that butchery was a large part of the activities conducted in this area. Unfortunately, with the refit links between Subarea C2 and C3, it is difficult to establish which tools are related to which occupation.

A total of 1758 lithic items were found in Area C, including 1206 flakes, 489 microblades (40 are modified), 8 core parts, one burin, 15 burin spalls, 38 modified flakes and fragments, and 6 boulder spall scrapers. Another burin of exotic brown chert (C6) was found about 1 m to the southeast of Subarea C1. All but six of the modified flakes were made on local gray or black chert (84% of total Area C modified flakes), and most exotics were found in Subarea C3 (33% of total Subarea C3 modified flakes). This pattern, coupled with the greater number of material types and greater amounts of exotics (like obsidian), further distinguishes Subarea C3. Compared to all other Subareas in Component 3, Subarea C3 exhibits more curation patterns.

The modified flakes in Area C include 3 Type A, 7 Type B, 21 Type C, and 1 Type D (including conjoins and refits). Subareas C3 and C4 are most similar in modified flake distributions, 6-10% Type A, 19-20% Type B, and 69-70% Type C, vs. Subarea C2 with 20% Type A, 40% Type B, and 40% Type C. This may reflect different uses of modified flakes in these areas. Three of the four Type A flakes (exhibiting burin damage) in Component 3 were found within 2 m of the burin in Subarea C3, suggesting a specialized activity area. The total amount of lithic material for Area C is 193.40 g, with a weight density of 12 g/m^2, similar to other Component 3 areas. Clusters associated with microblades make up 94% of Area C by weight, and the subareas are all very similar, between 93-100%. The lack of formal tools in Area C suggests that a restricted range of activities were performed there.

Area C contained two Group B microblade clusters (materials C1 and R1) with 335 microblades, however the division of these among Subareas C2-C4 could indicate as many as six Group B clusters. Group B clusters constitute 69% of total Area C microblades, a lower proportion than any of the other areas. There were 40 microblades from nine Group A1 clusters, 42 microblades from five Group A2 clusters, and 61 microblades from five Group A3 clusters. Segmentation distribution and modification types (Figures 10.36-10.37) suggest microblade production, and inset production in Subarea C1, use in activity area and insert replacement on-site in Subarea C2, microblade production, inset removal and discard, use in activity area, and insert replacement on-site in Subarea C3, and microblade production, inset replacement on-site, and inset production in Subarea C4 (see above).

The delineation of activity sets within Area C is discussed above. There are three spatial clusters of tools, two of which are linked through refits (TC1 in Subareas C2 and C3 and TC2 in Subarea C4). The spatial relationships among the two, their relationships to the hearths and fauna, and differences in tool class co-occurrence suggest that these areas were used for microblade production and use and marrow extraction.

Faunal cluster F6b is directly associated with Area C, and is very similar to clusters F1, F3, F4, and F9. Inferred activities involve marrow processing of long bones. Faunal remains in cluster F6a may have been a disposal area relating to cluster F6b. Both wapiti and bison element portions were present in Area C, with an MNI of two animals. Given the distribution of fauna, a large portion likely remains unexcavated to the east.

The number of flaking events can be estimated at between 16 and 24 based on the considerations discussed above. Area C likely represents two short-term occupations, a smaller one associated with Subarea C3 and Feature 18, and a larger one associated with Subareas C1, C2, and C4 and Feature 12, more directly associated with faunal processing. Potential for post-occupational disturbance of the older occupation due to this palimpset of occupations is high, but given the overall spatial distributions of lithics and fauna, the effects are estimated to be minimal.

Area D

Area D is characterized as an area of lithic concentration measuring 4 m northwest to southeast and 2 m northeast to southwest (grid orientation). Two subareas can be delineated on the basis of lithic concentrations, Subareas D1-D2. The overall shape of Area D is an elongated oval, though the area is truncated in the southwest by the bluff edge. Faunal cluster F9 is centered on Area D, especially in and near Feature 14, and is interpreted as a marrow processing area.

Three hearths are directly associated with Area D, Feature 13 (8900±40 BP, β-181679) in Subarea D1 and Feature 14 (8760±40 BP, β -191558) and Feature 16 (8820±50 BP, β-183109) in Subarea D2. All three hearths are contemporaneous (see Chapter 6 for a discussion of dating Feature 14). The critical issue in Area D is correlating the hearth features with the lithic concentrations.

Subarea D1 is situated directly south of Feature 13, and no other lithic concentration is found near Feature 13. Relatively few faunal remains were found associated with Feature 13, though a large quantity was found south of that hearth in the area of greatest lithic concentration. A small cluster of flakes and a short axis beveled flake was found about 2 meters to the northeast, and this has been assigned to Subarea D1. Subarea D2 is situated between Features 14 and 16, and could relate to either one or both. Refit data show internal coherence within each subarea, consistent with small, localized tool maintenance and microblade production loci.

A total of 1851 lithic Items were found within Area D, including 1599 flakes, 225 microblades (11 are modified), 8 cores and core parts, 1 biface, two burin spalls, two short axis beveled flakes, 13 modified flakes, and one small boulder spall scraper. The modified flakes include 1 Type A, 3 Type B, 6 Type C, and 3 Type D. All but one of the modified flakes were made on gray or black chert or white rhyolite, suggesting relatively rapid successional manufacture, use, and disposal of these implements. The total amount of lithic material for Area D is 257.68 g, with a weight density of 23 g/m^2, about twice that for Areas A, B, and C. Even with the removal of the biface and microblade cores, the density is 18 g/m^2, still higher than the other areas. Clusters associated with microblades make up 64% of Area D as a whole by weight, but the subareas are very different, Subarea D1 with 93% and Subarea D2 with 16%. These patterns indicate that a wide variety of tasks took place in Area D relative to Areas A and C. Subarea D1 reflects microblade production and use and Subarea D2 reflects unifacial and bifacial maintenance and use.

Area D contained one Group B microblade cluster with 180 microblades (80% of total Area D microblades), 6 microblades from one Group A1 cluster, and 36 microblades from one Group A2 cluster. Segmentation distribution and modification types (Figures 10.36-10.37) suggest microblade production in Subarea D1 and inset replacement in Subarea D2. There is little evidence of inset production for new composite implements, inset removal and discard, and microblade use in an activity area at Area D.

The delineation of activity sets within Area D is discussed above. There is one cluster of tools, situated somewhat between Subareas D1 and D2, consisting of bifacial and unifacial tools and modified flakes. Interestingly, there are no boulder spall scrapers (except for one small fragment near Feature 13), a common tool class in Areas B and C. The spatial relationships among the microblade cores and microblade production area as defined by refitting suggests use within one area and discard at the periphery of the activity area. The spatial relationships among the tools, debitage, hearths, and fauna suggest that Subareas D1 and D2 were likely contemporaneous, and tasks included microblade production, unifacial and bifacial tool maintenance and use, and marrow extraction.

Faunal cluster F9 was directly associated with Area D, and is very similar to clusters F1, F3, F4, and F6b. Inferred activities involve marrow processing of long bones. Only wapiti element portions are present in Area B, with an MNI of 2.

The number of flaking events can be estimated at seven based on the material types (where n>3), four in Subarea D1 and three in Subarea D2. Area D likely represents one short-term occupation given the lithic debris density, small number of material types and position of hearths and lithic concentrations. Potential for reuse is considered low and potential for post-depositional disturbance is low.

Area E

Area E is characterized as an area of lithic concentration measuring 3.0 meters east to west and 2.5 m north to south (grid orientation). One hearth is directly associated with Area E, Feature 2, dating to 9510±50 BP (β-134098). There are no obvious subdivisions of the lithic items, though there is a separation of the two major materials, Ch1 to the east and C1 to the west, with R2 and Ch3 at their junction near Feature 2. A series of Ch1 core tablets refit or conjoined in the eastern area. A total of 488 lithic items were found in Area A, 369 flakes, 105 microblades (13 are modified), seven burin spalls, and one modified flake. The burin spalls were made on common material (Ch1 and C1), but the modified flake was made of jasper, and had burin like damage. Only one other jasper flake was found, suggesting curation. The total amount of lithic material is 46.18 g, with a weight density of 7 g/m^2, about half of Component 3 areas. This suggests that the occupation intensity of Component 2 was less than that of Component 3. Clusters associated with microblades make up 89% of Area E materials by weight, indicating preponderance of microblade production but also unifacial and/or bifacial tool maintenance and perhaps use.

Area E is different from most of Component 3 subareas (except C1 and D2) in that it is not dominated by Group B microblade clusters. Ninety-six percent of Area E microblades are from two Group A2 clusters. Segmentation distribution and modification types suggest microblade production and inset replacement on-site. There is little evidence for inset removal and discard, use in an activity area, and inset production (new composite implements). The modified flake with burin damage could indicate that composite tools may have been manufactured, though no tools have been found and the faunal remains are rather poorly preserved. The faunal remains were located outside of the main concentration area of lithics and direct association, beyond the general stratigraphic and spatial association cannot be established.

The number of flaking events can be estimated at four, though two additional exotic materials are present with one or two specimens each. Area E likely represents a short-term single occupation given the lithic debris density and small number of material types. Potential for reuse or post-depositional disturbance is considered low.

Area F

Area F is characterized as an area of lithic concentration measuring 2.5 meters northwest to southeast and 1.0 m northeast to southwest (grid orientation). One hearth is directly associated with Area F, Feature 17, dating to 9400±50 BP (β-183110). There are no subdivisions of the lithic items, and almost all of the items were found within a single 25 x 25 cm area associated with the center of Feature 19 (cobble ring) (see Figure 9.8). No refits were found. A total of 340 lithic items were found in Area F, 336 flakes, one burin spall, one short axis beveled flake fragment of exotic material (for this area), two modified flakes, and one boulder spall scraper. No microblades were found. The two modified flakes and beveled flake fragment were all on gray chert, of which only 11 items were made (3% of total). The total amount of lithic material is 13.23 g, with a weight density of 7 g/m^2, about half of Component 3 areas. This suggests that the occupation intensity of Component 2 (Areas E and F) was less than that of Component 3. Given the small sizes and morphology of Area F flakes, bifacial or unifacial tool maintenance and unifacial tool use is indicated.

The number of flaking events can be estimated at two based on material types. Area F likely represents a short-term single occupation given the lithic debris density and small number of material types. Potential for reuse or post-depositional disturbance is considered low.

Area G

Area G is characterized as an area of lithic concentration measuring 3 m north to south and 2 m east to west (grid orientation). One hearth is directly associated with Area G, Feature 7, dating to 8660±40 BP (β-167396). There are no subdivisions of the lithic items, and almost all of the items were found within a small area about one m south of Feature 7 (see Figure 10.46). No refits were found. A total of 28 lithic items were found in Area G, 27 flakes and one modified blade, all of the same material, black chert. No microblades were found. The total amount of lithic material is 5.69 g, with a weight density of 2 g/m^2, well below Components 2 or 3 areas. This suggests that the occupation intensity of Area G was less than that of either Component 2 or 3. Bifacial or unifacial tool maintenance and perhaps use is indicated.

A faunal cluster is directly associated with Area G, with 149 fragments and a total weight of 82.4 g. The average weight per fragment was similar to Component 3. While no elements can be identified to species, all are large to very large mammal, and are likely wapiti, bison, or caribou. Faunal remains are similar to clusters F1, F3, F4, and F9 in Component 3, suggesting marrow extraction.

The number of flaking events can be estimated at one based on the material type. Area G likely represents a short-term single occupation given the lithic debris density and small number of material types. Potential for reuse and post-depositional disturbance is considered low.

Area H

Area H is characterized as an area of lithic concentration measuring about 0.3 m in diameter. No features or fauna are associated with Area H, and no refits were found. A total of 15 lithic items were found in Area H, five flakes, one microblade distal segment, and nine modified flakes, all of black chert. The total amount of lithic material is 12.44 g, with a weight density of 50 g/m^2, well above Components 2 and 3 areas. This is due to the larger modified flakes. Use of modified flakes and perhaps bifacial or unifacial tool reduction or maintenance occurred in Area H.

The number of flaking events can be estimated at one or two based on the material type. Area H likely represents a very short-term single occupation given the lithic debris density and small number of material types. Potential for reuse and post-depositional disturbance is considered low.

Area J (Component 5)

Area J (Component 5) is characterized as an area of lithic concentration measuring 5.5 m northwest to southeast and 1.0 m northeast to southwest (grid orientation). A substantial portion of Component 5 is likely unexcavated to the north. No features or refits were found in Area J. There are no obvious subdivisions of the lithic items, and all have the same general spatial distribution suggesting contemporaneity of all clusters. A total of 86 lithic items were found in Area J, and all were unmodified flakes. The total amount of lithic material is 2.78 g, with a weight density of 1 g/m^2, well below Components 2 and 3 areas.

Faunal remains were found within Component 5 and within stratum Y3 throughout the Lower Locus (see Chapter 6). Only 14% of the faunal remains by weight were directly associated with Area J artifacts, including a wapiti 2^{nd} phalanx. There are numerous other wapiti faunal remains from stratum Y3 and this association supports the linkage with wapiti elements throughout this stratum. While the sample is too small to derive strong inferences, the dispersed nature of the faunal remains suggests a very different processing strategy in Component 5 than in Components 3 and 4, assuming that all of stratum Y3 fauna are associated.

The number of flaking events can be estimated at three based on the material types, though two Ch3 flakes were found suggesting a fourth flaking episode. Area J likely represents a short-term single occupation given the lithic debris density and small number of material types. Potential for reuse and post-depositional disturbance is considered low.

Area K (Component 1)

Area K (Component 1) is characterized as an area of lithic concentration measuring at least 5.25 m northeast to southwest and 3.25 m northwest to southeast (grid orientation). Significant spatial disturbance is present given taphonomic analysis (Chapter 4), caused by colluvial slope wash. However, given the few material types (and the dominance of green chert (C5)), the stratigraphic separation from other components, and the general spatial coherence, a single component and single occupation is inferred. Most of Area K is estimated to be nearly completely excavated, though some cultural materials may remain to the east. Given the potential for spatial disturbance, the entire Component is analyzed as a single area. However, there are two apparent lithic concentrations, a large one centered in Block R dominated by green chert and quartz (C5 and Q), and a much smaller one in Block O, about 2 meters to the southwest, dominated by andesite (An).

No features were found in Component 1, and two refitted flakes were located 20 cm apart. A total of 2040 lithic items were found in Component 1, 2034 unmodified flakes, two biface fragments, one burin spall, and three modified flakes. The formal and informal tools were primarily made on green chert, though one modified flake was made from Qa2. The total amount of lithic material is 161.52 g, with a weight density of 7 g/m^2, similar to Areas E and F from Component 2, but half of that exhibited by Component 3 areas. Use of modified flakes, and bifacial and perhaps unifacial tool reduction and/or maintenance occurred in Area K. Given the very small tool assemblage, further functional inferences are unwarranted.

Faunal remains were found in very low quantities within Component 1, including 35 fragments weighing a total of 7.5 g. The limited remains indicate a number of size classes, including unidentified birds and small to very large mammals. All of these are found to the south of the main lithic concentration. This spatial patterning may point to a specific area of faunal processing relative to the lithic concentrations.

The number of flaking events can be estimated at three based on the material types, though multiple tools could have been maintained from the large number of green chert flakes (n=1764). Component 1 likely represents a short-term single occupation given the lithic debris density and small number of material types. Potential for reuse is considered low but post-depositional disturbance is considered high given the colluvial feature.

Component Level Analysis

This section summarizes use of space in each component, focusing on organization and relationships among features, lithic concentrations, and faunal clusters. Components 1, 4, and 5 are examined in the preceding section, and are only summarized in this section, given the relative lack of tools and spatial organization data. Components 2 and 3 are examined with respect to occupation sequence and duration, modes of lithic use, potential for reoccupation, site structure, and spatial organization. Component level summary data is presented in Table 10.11. Spatial organization of each Component is illustrated in Figures 10.43-10.47.

Component 1

Component 1 consists of a single large activity area, somewhat dispersed by a colluvial feature to the west of the lithic clusters (Figure 10.43). All cultural materials were likely deposited by a single short-term occupation. No hearths or other features were found, suggesting use of the site as a flaking station and observation post. The dispersed faunal remains do not form clusters on the basis of taxonomy or size, suggesting an ephemeral short-term station. Local concentrations of andesite and quartz flakes in Component 1 suggests that spatial disturbance can be overcome in understanding the use of space. The faunal remains were located to the south of the lithic concentrations, and form a "U" within which the highest quantity of flakes were found, including two bifaces, a burin spall, and two modified flakes. This relatively discrete depositional set likely reflects an activity area in the center of the "U."

Component 2

Component 2 consists of two widely separated activity areas, one associated with a microblade production area (Area E) and the other associated with a biface or uniface maintenance/use area (Area F) (Figure 10.44). While the radiocarbon dates on the two features are consistent with contemporaneity, the differences in the material types and the wide spatial separation suggest they are from separate occupations. The microblade production area is very similar to Area D in Component 3, though the density data suggest lithic reduction activities at

Table 10.11 Component level summary data.

Comp.	*Analytical area (GIS area) (m^2)*	*N items*	*Flakes*	*Micro blades*[8]	*Cores*[9]	*Tools*[10]	*Total weight (g)*	*Count density* (n/m^2)*	*Weight density* (g/m^2)*	*Micro-blade wt. %†*	*Tools*
1	21.8 (24.2)	2040	2034	-	-	6	161.52	94 (84)	7 (7)	0	2 BIF, 1 BS, 3 MF
2	9.0 (4.5)	828	705	105	6	12	59.41	92 (184)	7 (13)	63	8 BS, 1 ES, 3 MF, 13 MMB, 1 BSS
3	97.0 (27.8)	7077	5591	1350	26	110	788.72	73 (255)	8 (28)	78	2 BIF, 32 BS, 3 BU, 3 ES, 2 SS, 67 MF, 134 MMB, 8 BSS
4	3.3 (2.7)	43	32	1	-	10	18.13	13 (16)	5 (7)	0	1 BU, 9 MF
5	2.0 (2.0)	86	86	-	-	-	2.78	43 (43)	1 (1)	0	none

* Density values in parentheses are based on GIS area estimates

[8] Microblades include both modified and unmodified microblades.
[9] Cores include microblade cores, core fragments, core tablets, and facet rejuvenation flakes.
[10] Tools include all lithic tools except for modified microblades, boulder spall scrapers, and cobble tools.

about half of the intensity in Component 3. The lithic clusters are organized relative to associated features, at a distance of 50-100 cm. The few scattered faunal remains are difficult to interpret, and are widely dispersed. The primary differences between Component 2 and Component 3 microblade concentrations relate to core morphology, lack of faunal remains, and relative lack of non-microblade tool maintenance areas and expedient tool use. Many of the patterns of lithic subarea morphology, feature use, and orientation of lithics to Feature 2 are similar to Component 3 (see below).

Component 3

Occupation sequence and duration

The relationships among the areas within Component 3 must be examined before overall assessment of site organization at the component level is attempted. From the data described above, radiocarbon, faunal, and feature analyses, I assess alternative hypotheses with respect to occupation sequence described in Chapter 5. Of the scenarios described in Chapter 5, the most plausible one is Scenario B1, where one occupation occurred in the northeast portion of the site, associated with Feature 18 (and perhaps charcoal scatter Features 8 and 11), around 10,200 cal BP. A second occupation occurred at Areas A, B, C, and D around 10,000 cal BP. The contemporaneity of these four areas (*sans* Feature 18) cannot be refuted based on the radiocarbon and contextual data.

The first occupation is designated Component 3, occupation A. This consists of Feature 18 and lithic raw materials B, C6, C8, Ch2, D, O, and S. Some of the C1, C4, J, and R2 materials may be related. This occupation is not considered associated with the faunal remains in Area C. Some of the tool cluster TC1 is included in this occupation, but further precision awaits more detailed analyses. The second occupation is designated Component 3, occupation B. This consists of Features 1, 3, 9, 10, 12, 13, 14, and 16, all faunal materials in Component 3, and all lithic materials in Component 3 except for those lithic materials listed above in Subarea C3. A possible third and later occupation may have occurred with the construction and use of Feature 5 and the deposition of tool cluster TB3 in the eastern portion of Subarea B2. Given lack of clear evidence for a separate occupation, it is not formally designated.

The relationships of Area A with the other Component 3 areas are difficult to establish conclusively. Stratigraphic and radiocarbon correlations are consistent with contemporaneity among Areas A, B, D, and parts of C. No lithic or faunal refits were observed within Area A or between Area A and other areas, but the nature of the assemblage (dominated by tiny maintenance flakes), makes refits unlikely. It is possible that Area A represents a separate occupation from Areas B, C, and D, given the distance between the areas. However, given the present data, the hypothesis that Area A is contemporaneous with Areas B, C, and D cannot be refuted. Areas B and D appear linked on the basis of lithic and faunal refits. Areas B and C also appear linked on the basis of distribution on either side of a faunal cluster with numerous articulated element portions. This patterning may be the result of chance, but the coherence of the faunal spatial model developed in Chapter 6 argues for contemporaneity.

Occupation duration is estimated to be very short, on the order of less than a day to a few days. No cleared ground consistent with swept areas or sleeping areas was observed, and the relatively close proximity of processed faunal remains suggests a short occupation.

Site Structure and Spatial Organization

Component 3 exhibits considerable spatial organization, with respect to hearth features, faunal clusters, and lithic concentrations (Figure 10.45). Space maintenance such as clearing or sweeping was not observed, though faunal remains were distributed in patterned ways suggesting movement from a central staging area to peripheral hearth-based marrow extraction areas, and further to dispersed and aggregated disposal areas. The similarities in fauna among the processing areas suggest either contemporaneous use of the site by multiple social units situated at each hearth (Feature 1, Feature 3, Feature 5, Feature 12, Feature 14, and perhaps Feature 10) or similar use of the site by sequential occupations. Similar numbers of flaking events were evident, generally around 4-8 flaking events per hearth. This may indicate that similar numbers of persons were present around each hearth. The hearths with 9-12 flaking events are in areas where multiple occupations may have occurred (Subarea C3 and eastern portion of Subarea B2). This tight distribution could be a signal of a flaking mode. It is highly speculative to estimate group size per hearth. The average inter-hearth distance is around 2 m and the position of lithic concentrations generally in two areas per hearth suggesting a reasonable scenario of two to three persons at each hearth. The distance between Areas B-C and Area D suggests that two larger social units (e.g., kin groups) may have occupied the site together. The relatively large minimum number of large mammals represented (n=8) suggests cooperation.

Component 3 hearths are all similar in overall morphology, suggesting a similar function. There is no evidence of shelters, such as windbreaks or tents, and all Component 3 hearths are interpreted as outdoor men's hearths (see Binford 1978b). While some were spatially related to faunal clusters and contained burned bone, they were not likely used in a functional sense to facilitate processing, but probably for light and heat. Locally acquired wood was used for burning, and there is no evidence of wood storage nearby. There is no evidence of smearing of ash or dispersal of materials; this suggests that the hearths were quickly created, maintained for only a short while, perhaps several hours, and they may not have been extinguished. Reuse of hearth features is not evident, in the form of larger more amorphous oxidization and organic rich stains, and large amounts of scattered charcoal.

The morphology of the lithic subareas suggests a mode of site use. They were generally 2-3 m in diameter and off-set slightly to the side(s) of one or more hearths. None of the lithic concentrations were centered directly on a hearth suggesting the location of seating about 100 cm from the hearth centroid. The largest dimension was generally perpendicular to the hearth and extended for some distance on either side of the hearth (see especially Area A, Subareas B1, B2, B3, C2, and D2). This may suggest a seating arrangement of persons on one side of the hearth, leaving the opposite side open. In this manner, wind direction was inferred for each hearth (see above).

The density results for subareas in Component 3 show interesting patterning. Five of the areas are similar in their count and weight densities (A, B1, B2, B3, C, and D2). Subarea B4 measures reflect the relative lack of tools (which skew the weight) in this area. Subarea D1 shows the most difference in both count and weight density, and this is the only area where complete microblade cores were recovered. These patterns reflect more intensive microblade production in Subarea D1.

With the exception of the links between Areas B and D, the refits were generally confined to each subarea. While this pattern is expected given the very small size of most flakes and the discrete lithic clusters, it also supports the hypothesis that individuals generally maintained their tools at one particular hearth and subarea, rather than moving to different hearths.

Activities at the site appear to have been organized relative to features and faunal distributions. Modes of tool co-occurrence are present, including clustering of end and laterally modified microblades and burins, modified flakes, and bifacial and unifacial tools and related debitage, and dispersal of boulder spall scrapers and some modified flakes in the interface between lithic and faunal concentrations. Archaeologists do not yet have a model for how bifacial, unifacial, and blade and microblade tools were used in systemic contexts, but variability in microblade attributes at various aggregate levels suggests that microblades as end products were used within a single system for a variety of tasks. Modified flakes show a wide range of variability in size, edge thickness, edge angle, edge shape, and size. Usewear studies should provide useful information regarding function, but the present limited studies suggests that formal typologies and usewear may not be totally correlated. Modified flakes are present in various quantities in different areas. For instance, Subareas B1, B2, B3, and B4 have relatively few or no modified flakes, where Subareas C2, C3, and C4 have numerous modified flakes. Subareas B2, C2, C3, and C4 all have high percentages of microblade clusters, yet modified flakes are differentially associated. The morphological and technological patterns observed for Component 3 modified flakes can hopefully be used as a template for further analysis of an important part of many Paleolithic sites.

Rates of tool discard can be estimated by the wear intensity and number of modified margins on expedient and formal tools. These data indicate that expedient tools were both created on-site and curated from other locations. Most of the modified flakes were on many of the largest flakes at the component. The damage and modification on most of these implements were generally light to moderate, and were likely created, used, and discarded in quick succession. A number of modified flakes are also present in the form of small fragments, suggesting that breakage rather than expediency led to their discard. Formal tools were generally heavily used, and a number are broken (short axis beveled blade in Area D), recycled (biface in Area D), or burinated (short axis beveled blade in Area B). The fact that many more bifaces and unifaces were likely maintained and used on site based on the debitage characteristics than were discarded suggests an overall curated strategy for formal tools and a mixed strategy for expedient tools. These patterns have implications for planning and hunting strategies (see Chapter 11). Microblade technology is consistent with very high residential mobility.

Component 4

Component 4 consists of two widely separated activity areas, both characaterized by relatively few unmodified flakes and a high percentage of modified flakes and one modified blade (Figure 10.46). No date is available on Area H, but the radiocarbon date associated with Feature 7 in Area G and similar depths above Component 3 supports contemporaneity in these two areas. Both areas are dominated by a single material type, black chert (C4). The Area G lithic materials are associated further from the hearth than in Components 2 or 3, but a few items were found directly within the hearth, including a modified blade. The lack of boulder spall scrapers and the presence of modified flakes could indicate different strategies of butchery and processing, but the overall faunal patterns suggest similar processing behaviors.

Component 5

Component 5 consists of a diffuse lithic scatter, with the lowest weight density of all other components (Figure 10.47). No tools have been recovered, and this component has not been excavated to the point where inferences can be drawn about spatial organization. The faunal remains outside of Blocks Y and AA within stratum Y3 cannot be conclusively linked to Component 5 without further excavation, but if they are associated, the lithic concentration is spatially segregated from the faunal scatter.

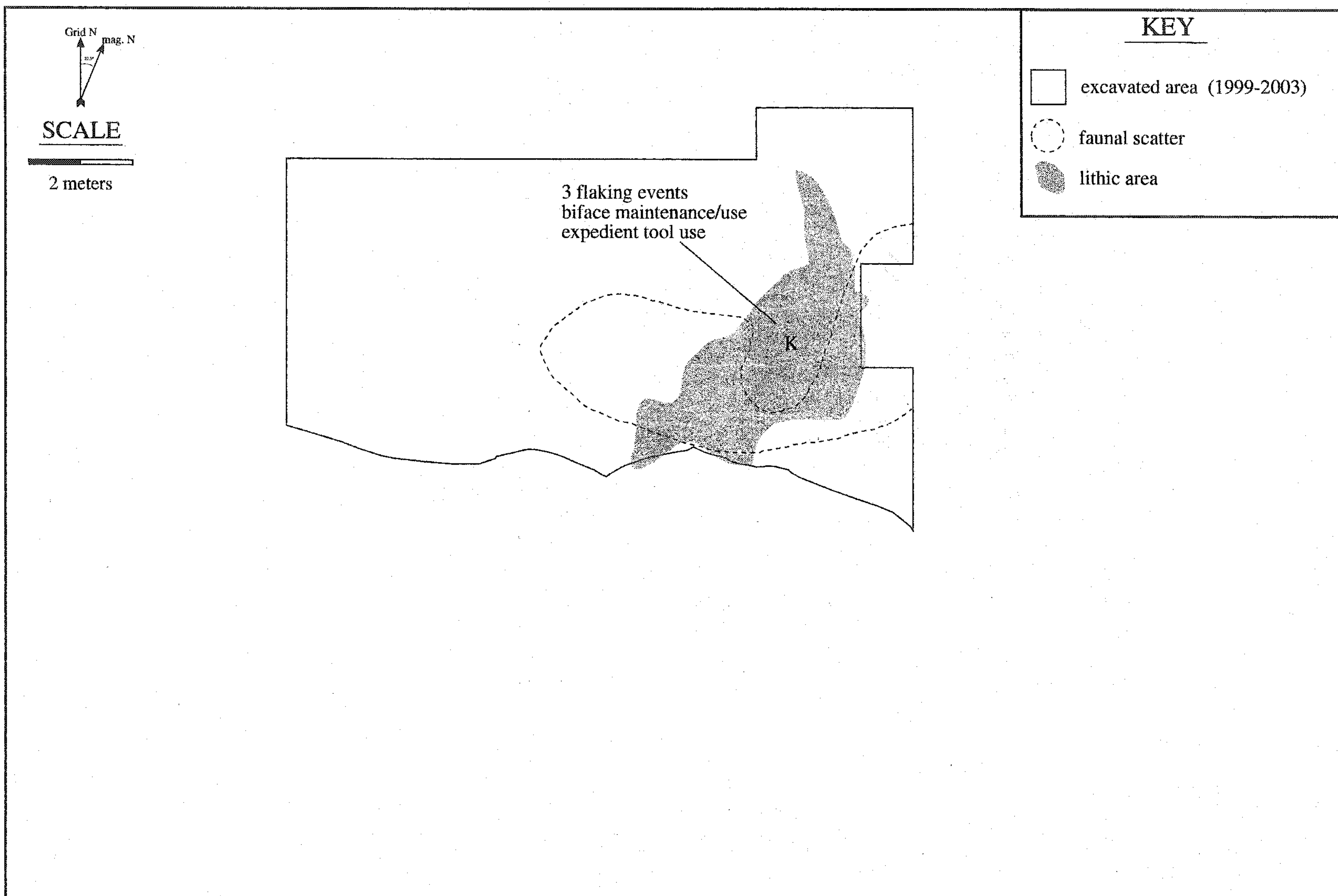


Figure 10.43 Interpretation of Component 1 lithic activity area.

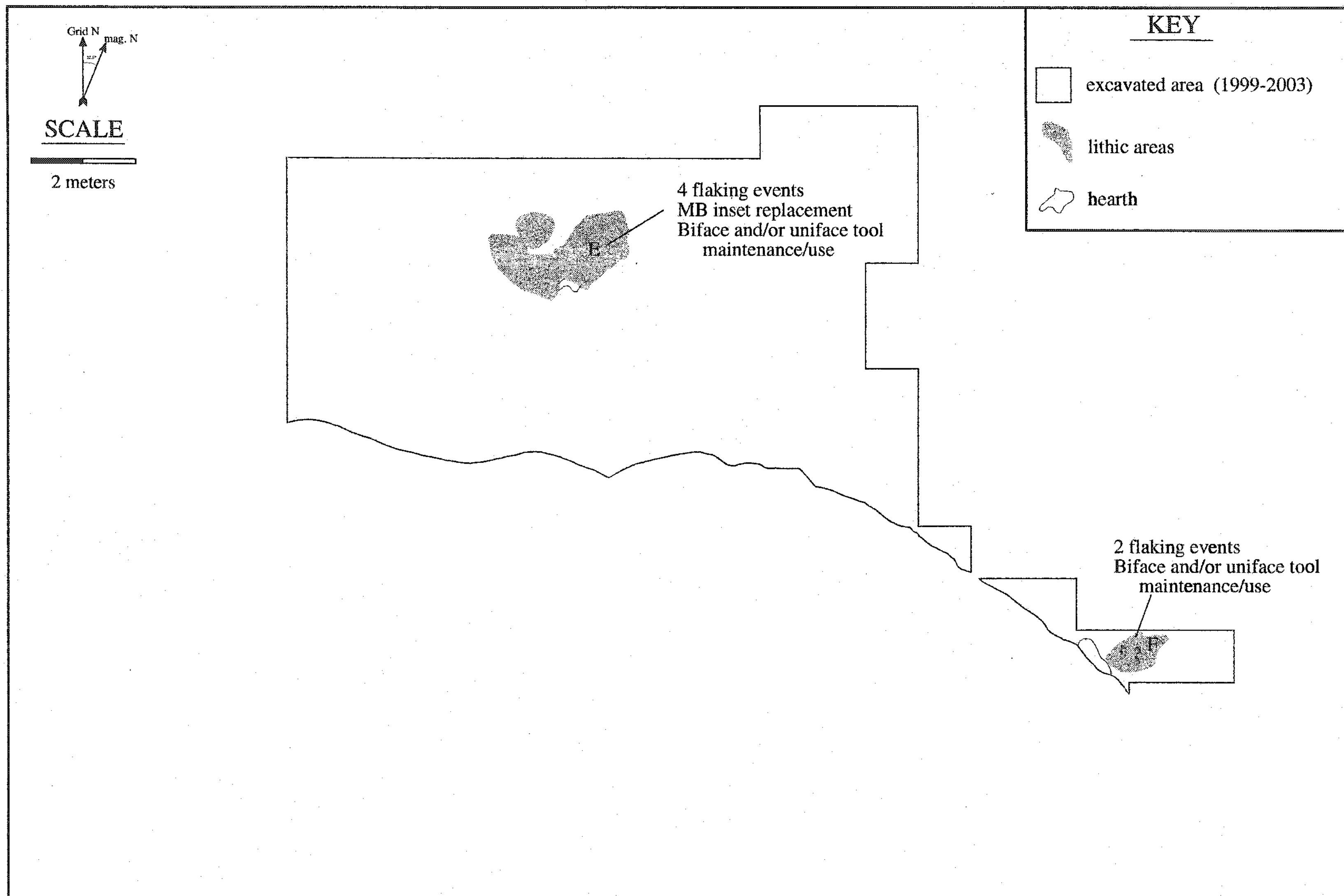


Figure 10.44 Interpretation of Component 2 lithic activity areas.

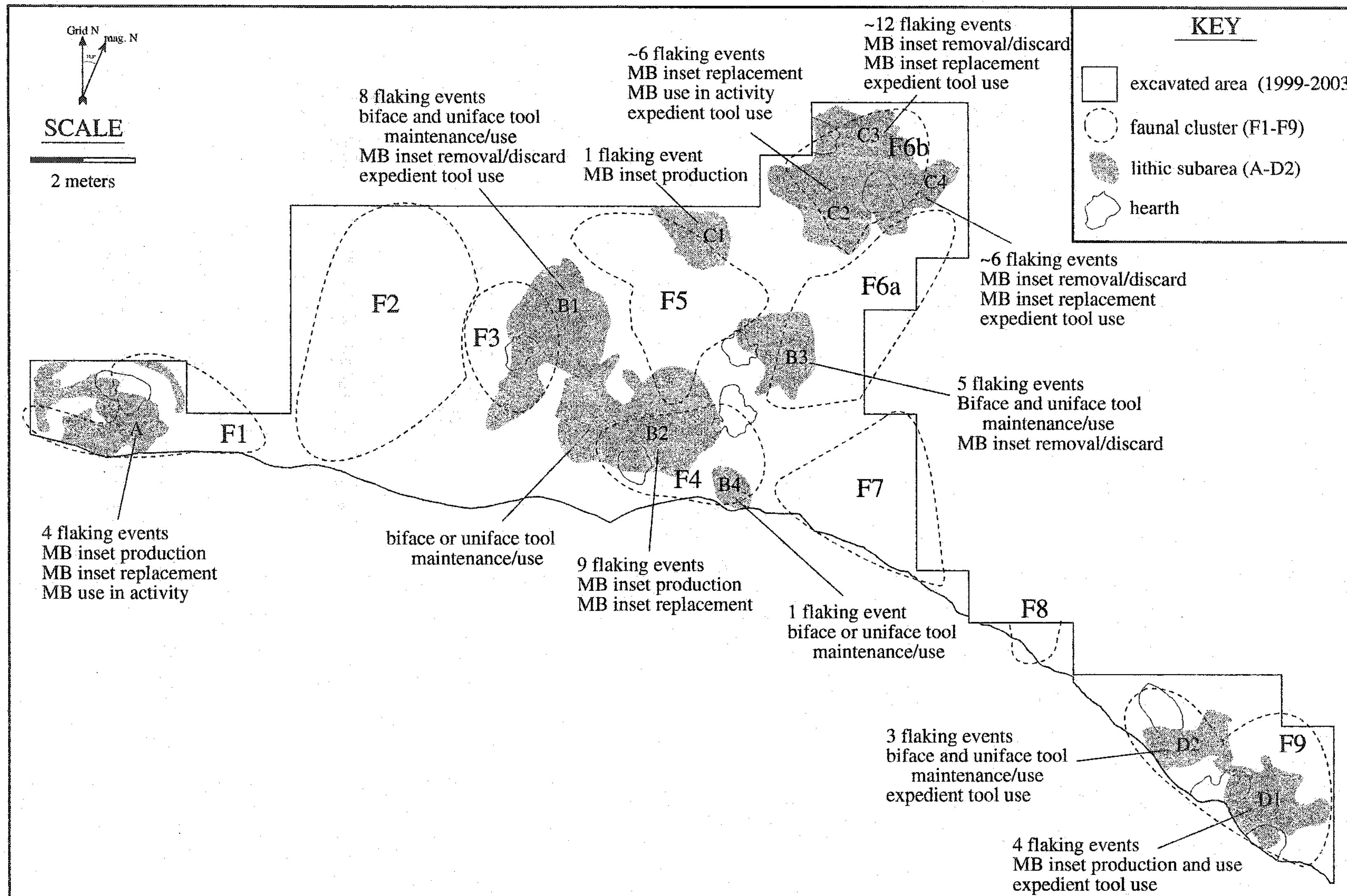


Figure 10.45 Interpretation of Component 3 lithic activity areas.

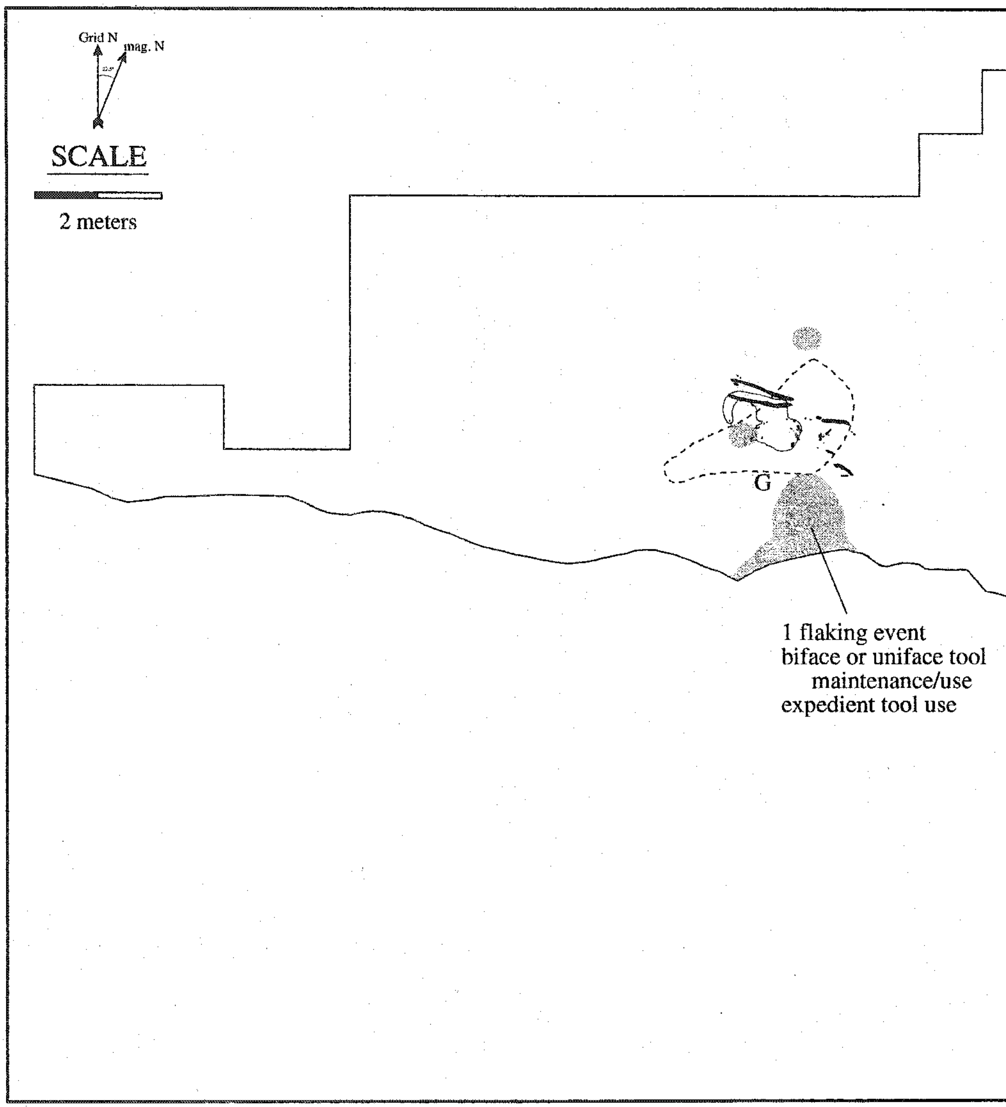
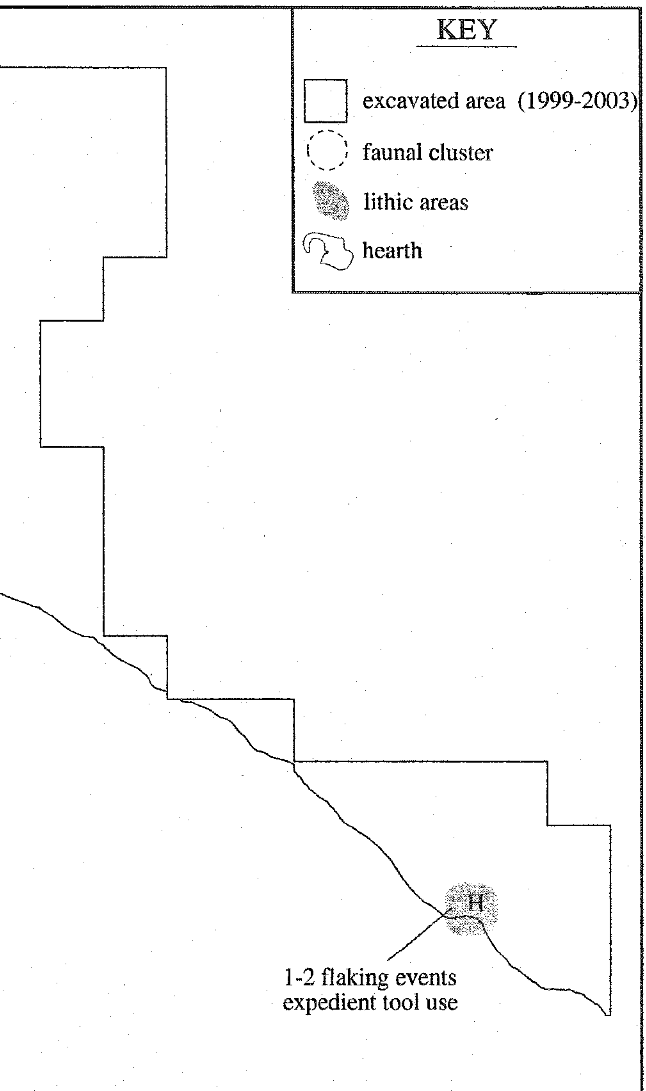


Figure 10.46 Interpretation of Component 4 lithic activity areas.


KEY
excavated area (1999-2003)
faunal cluster
lithic areas
hearth
H
1-2 flaking events
expedient tool use

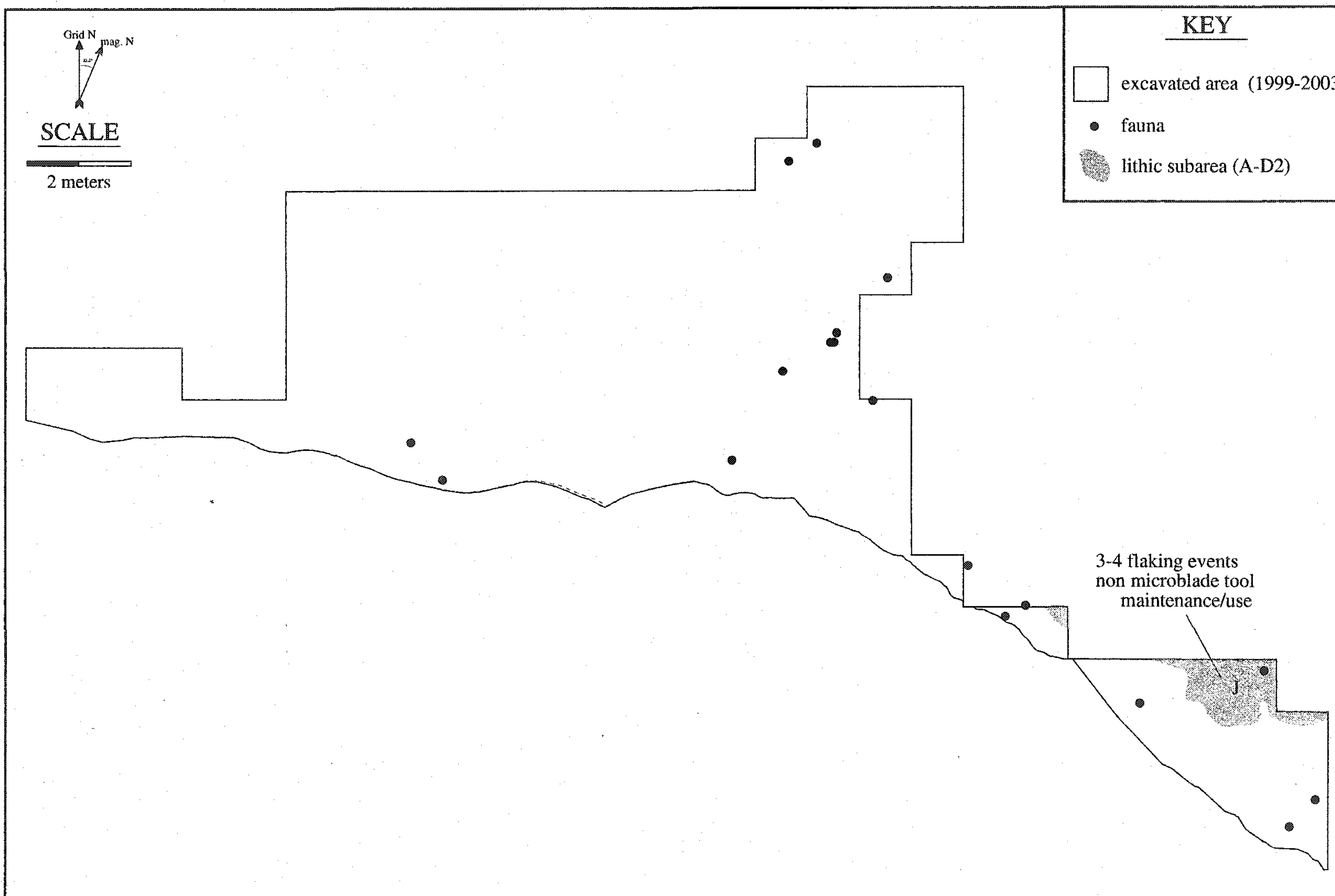


Figure 10.47 Interpretation of Component 5 lithic activity area.

Chapter 11. Conclusions

This chapter is composed of two sections. The first is a dimensional analysis of site structure at Gerstle River Component 3. The dimensions considered here primarily at the level of intra-site patterning includes activities, technological organization, disposal modes, organization of space, locational, site structural, and compositional redundancy, storage facilities, seasonality, and ecological and topographic location. Dimensions that have considerable implications for intersite variability include group size and social structure, methods of faunal procurement, economy, and settlement system.

The second section is composed of general conclusions and inferences that may be extended beyond the component level to situate patterning in the archaeological record in this region. Summaries of important patterns from various analyses in this dissertation are presented, conclusions are offered with respect to the research objectives stated in Chapters 1 and 2, and implications for future research are explored.

Dimensional Analysis of Site Structure

The data classes, analyses, and discussions in the previous six chapters are used to examine a number of dimensions of site structure and organization, generally following Binford (1978b, 1983:144-192) and Newell and Constandse-Westermann (1996). These dimensions can only be explored from a foundation established in Chapters 4 through 10.

An aspect of site structure that can affect interpretation that is not examined in Chapter 10 involves remains resulting from palimpsets of activities by the same population at approximately the same time. There is some disagreement among ethnoarchaeologists about the spatial occurrence of multiple simultaneous activities within a site. Yellen (1977a:134) suggests that activities are not likely to be spatially distinct whereas Binford (1978b:354) notes that specific tasks cannot physically be located in the same area simultaneously. Simek (1989:59) notes that activities are local processes and cannot be examined at the level of the site or component. Potential conditioning factors may be number of site occupants, duration of occupation, and social context of the activities (Yellen 1977a). The approach taken in this section is that while tasks are likely organized at a local scale, multiple tasks may result in a palimpset, and independent contextual variables should be examined for structural patterns.

Intrasite Dimensions

Activities

Various activities can be inferred from the archaeological record of Gerstle River Component 3. Figure 11.1 illustrates an activity sequence model for Component 3, with three phases of use, initial, occupation, and abandonment (following Stevenson 1991). While it is possible that the final spatial patterning in the component may not directly reflect the entire range or location of activities that occurred during the occupation, several factors mitigate this possibility. First, the vast majority of the cultural material consists of tiny maintenance flakes that are unlikely to have been moved after their deposition. Second, the lack of structures and the artifact density suggest that the encampment was short-term. Third, the absence of high meat yield elements suggests removal from the site, which also indicates a short-term occupation. Finally, the relative lack of dispersal of lithic clusters suggests that re-occupation or extended occupation did not occur. The three phases of site use (initial, occupation, and abandonment phases) included four main groups of activities, feature creation and maintenance, expedient tool manufacture and carcass processing, formal tool maintenance (including microblade production), and other activities that may not leave archaeological traces.

Specific activities occurring on-site include microblade production (inset replacement, production, and use), composite implement repair (inset discard and replacement), bifacial and unifacial tool maintenance and use, and expedient tool use all in the context of discrete lithic concentrations positioned very near open unlined hearths. Faunal data indicate that carcass portions were brought to the site and placed in a central "staging" area. Element groups were removed from the carcass and taken to ancillary processing areas at the periphery of the staging area where marrow was extracted, perhaps with the use of large anvil stones. Some larger faunal fragments were placed (i.e., tossed) into agglomerated and dispersed disposal areas (bone dumps) away from this processing periphery.

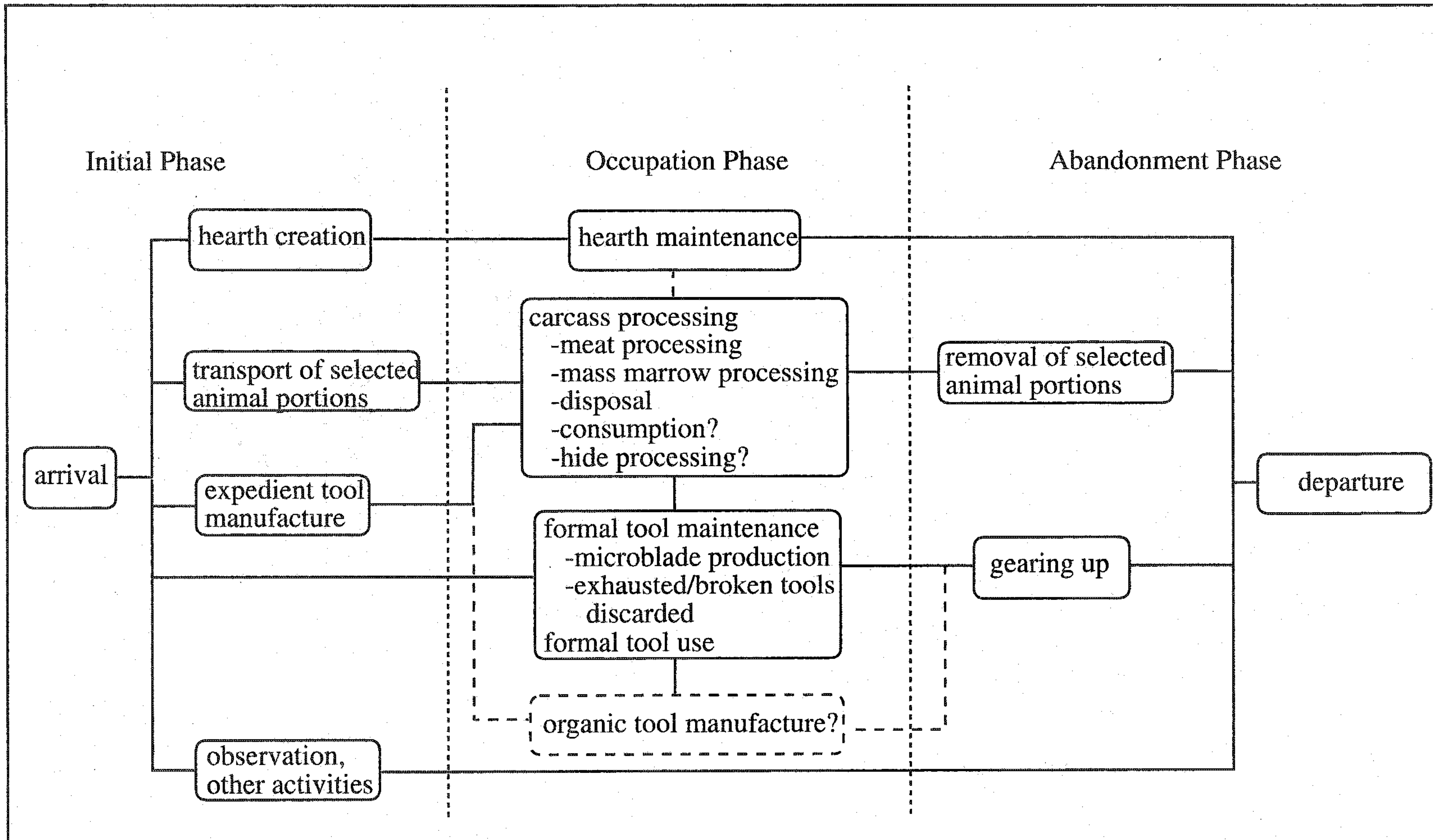


Figure 11.1 Component 3 activity sequence model.

Other inferred activities include gathering local shrubs for firewood, hearth construction and maintenance, consumption of berries, including lingonberry and red raspberry, and observation, either from the Lower Locus or from the hilltop to the south. Other categories of activities that may have been performed at Gerstle River Component 3 include talking, playing, and sleeping/resting. The presence of boulder spall scrapers could indicate hide processing (Morlan 1973a:29-32), though the edge damage and spatial distribution suggests they were used to disarticulate the wapiti and bison. Limited consumption may be present, given the location of marrow processing areas around hearths and the presence of some calcined bone in many of the hearths. Roasting of certain animal portions could have occurred.

Activities that might be expected but were not observed in the archaeological record include early stages of lithic reduction and tool manufacture and composite implement construction, though the presence of an elongate mammoth ivory rod may have been a preform. However, no antler or worked bone was found at Component 3. Hide working and other activities that require more space may have occurred at the periphery of the site, in areas not excavated.

The interrelationships of maintenance and use of lithic tools and faunal processing cannot be securely established on the basis of formal morphology and spatial location except for spall scrapers. Spall scrapers were unique among stone tools in their location at the interface between lithic concentrations (activity areas), and the staging area (faunal cluster F5). Another group of spall scrapers was found at the edge of Area C, and may represent an interface with an unexcavated faunal cluster to the north. The dominant technological task was microblade production, though there were areas of biface and uniface maintenance and use interspersed with the microblade clusters. There does not seem to be any direct evidence of use of microblades or composite tools in butchering, but it is a clear possibility, especially for butchery tasks requiring a sharp thin edge (e.g., filleting). The variability in modified tools may indicate that some of them could have been used for faunal processing. There are very few unifacial and bifacial tools recovered at the site (i.e., abandoned by site occupants), though 13 discrete lithic clusters not associated with microblades suggest that a number of implements were taken from the site after maintenance/use. From the items that were left, bifaces and short and long axis beveled flakes (unifacial end scrapers and side scrapers) were present. It is conceivable that animal processing for non-food items may have occurred, such as hide processing. The lack of hafts would suggest that hafted lithic tools were removed and discarded, but that the hafts were conserved for future use, given the generally good preservation at the site.

During the abandonment phase, high meat yield carcass portions were removed from the site in the form of dried or raw animal portions. A process of gearing up in anticipation for future activities may have acted to further situate items around the site. The hearths were not likely put out (assuming they were still burning), as there is no scattering of charcoal, except possibly in relation to Features 10, 12, and/or 18. There is no indication of caching or organizing bones, wood, or tools upon departure in anticipation of return. In addition, the vast majority of the flakes were too small to be used as blanks for future tools.

Technological Organization

One way to conceptualize the technological organization at Gerstle River Component 3 is through the idea of personal gear rather than task-specific toolkits (Binford 1978b). Personal gear might include a number of curated tool classes like composite implements and microblade cores, burins, and billets to maintain them, bifacial tools, and unifacial tools. The maintenance of these tools undertaken while at the site may have been specific to each individual. One person may have needed a new slotted implement, another may have needed to repair a slotted implement, while another may have needed to sharpen a bifacial knife. Using this model, each discrete location of debitage concentration could reflect the specific needs of one individual. The small absolute size of most clusters in terms of flake quantity and weight suggests a relatively short period of lithic maintenance[1]. Tools relating to personal gear, more likely to be curated and conserved, may be discriminated from task-specific expedient tools, such as modified flakes and spall scrapers. While there is evidence that some modified flakes may have been curated (i.e., no flake scatter of the same material or similar sizes), these tools have relatively low modification intensities, and percent of modified edges is relatively low (43%). The lithic tools suggest that two different organizational modes were in use at the same time, curated personal gear and expedient task-specific implements.

[1] Component 3 had an average of 90±132 flakes per cluster, excluding gray chert, which could encompass a number of material types.

The formal tools appear to be highly curated, and have evidence of recycling and maintenance through burination or resharpening. From this, it might be inferred that certain tool classes (bifaces, unifaces, and burins) may have been designed for relatively long use-lives. High quality lithic raw materials were used for expedient tools as well, and at Gerstle River Component 3, most of the larger flakes were used in this way. The occurrence of burins and concave edged modified flakes indicate that organic tool manufacture or maintenance may have occurred, though only one organic implement was recovered. This suggests that organic implements or blanks may also be highly curated, especially high quality ivory.

Disposal Modes

Binford (1978b) demarcates six behaviors relating to disposal: dropping, tossing, dumping, resting, positioning items (caching), and clearing. Most of these classes of behavior can be inferred at Gerstle River Component 3, and the spatial relationships among these disposal modes can be used to characterize site structure. The small, discrete clusters of tiny unmodified flakes represent drop events, located in the area of detachment from the parent tool or core. These are clustered very close to hearth features. While larger items like large bones and tools may be dropped, tossed, positioned, or dumped, tiny debitage will not likely be moved in a piece-meal manner that would reflect a three-dimensional normal distribution. Debitage may be swept aside or brushed aside, but no negative or positive arcs of debris were observed. In a similar manner, portions of faunal clusters F1, F3, F4, F6b, and F9 were likely dropped, given their small sizes. Some fragments may have been struck as splinters when larger bones were smashed for marrow. The smallest fragments can thus be used to establish activity areas in the absence of arcs of debris or site furniture effects (e.g., clearing the floor of a semi-subterranean house).

Faunal remains in clusters F2, F7, and possibly F6b and F8 were likely tossed from areas of processing, in effect forming primary refuse areas. This process is described in more detail in Chapter 6. These clusters are characterized by large fragments and can be dispersed (cluster F2), the result of being tossed down slope, or aggregated (cluster F7), perhaps the result of a being tossed in a particular direction away from the activity area (cluster F4, in the latter case). Dumping, specific removal of aggregate material from one location (use) to another (disposal), could be linked with cluster F7. Most lithic items do not exhibit spatial patterns suggesting that they were tossed away from an area of use, except for the microblade cores in Area D, which were located at the edge of activity areas. However, these were still within two meters of the areas of their last use, and they may have been positioned in those areas.

An example of positioning items may also be found in faunal cluster F5, which was very different from all other clusters in terms of articulated low-yield elements, relatively little fragmentation, and relative absence of long bones. This cluster may represent a staging area where carcass portions were positioned for mass marrow processing at each of the processing clusters.

Two disposal modes, resting and clearing, could not be inferred from the extant data. Resting items (temporary placement for future removal) would be difficult to establish from archaeological evidence alone as it assumes an intention. Clearing or brushing clean areas of lithics and faunal remains (indicated by arcs of debris or abnormally dense concentrations) were not observed.

The disposal modes present at the site reflect the systematic use of space by occupants. Faunal clusters at different stages of processing were organized with respect to the hearths and associated processing areas. The apparent coherence of the staging area – processing area – disposal areas seen in the following sequences: F5-F3-F2, F5-F4-F7, and perhaps F5-F6b-F6a could indicate three social units interacting at the site, either contemporaneously, or at different times following the same general spatial organizational scheme.

Organization of Space

Activities in Gerstle River Component 3 were organized around hearth features. Faunal clusters with large element portions were generally segregated, inferred here to be staging areas or disposal areas. The faunal clusters directly associated with the hearth features and lithic concentrations were generally composed of smaller, fragmented, disarticulated fragments. The outer edges of most of the lithic concentrations remarkably conform to the outer edges of drop zones around hearths (Figure 10.39). The position of lithic concentrations around hearths indicated that one side of the hearth was not occupied. This is consistent with expectations generated from ethnoarchaeology (Binford 1978b). It is interesting to note that there appears to be little blurring among activity areas, which may suggest that the lithic maintenance/use events were relatively short term, situated within a small area of use, and was conducted and finished at the same place.

An inference can be made that all artifact classes are not organized within the site in the same manner. Microblade production areas generally correlated with microblade inset removal and discard areas, though there was some variability in how much of each task was performed within each subarea. Modified flakes were the most variable in spatial organization, present in a number of tight clusters (~50 cm diameter) along with isolated specimens within and at the periphery of activity areas. There were very few formal tools, and patterns of their final discard are ambiguous, though they are also located within activity areas. The single burin found outside a lithic subarea was located within faunal cluster F5, and may have been tossed from a use area on either side.

Locational, Site Structural, and Compositional Redundancy

Redundancy refers to "the degree to which similar activities will be conducted in the same place at different times" (Binford 1978b:354), and may be an important conditioning factor in site structure. The degree of redundancy may reflect the position of groups within a forager-collector continuum. Higher degrees of redundancy (fewer specialized sites or activity areas) may reflect the higher residential mobility of a forager strategy where lower degrees of redundancy may reflect the higher logistical mobility of a collector strategy (see Kelly and Todd 1988:236). Newell and Constandse-Westermann (1996:375) divide redundancy in terms of locational redundancy, site structural redundancy, and compositional or content redundancy.

Locational redundancy can only be evaluated in terms of inter-component and intersite variability, and a detailed study of the latter is beyond the scope of this paper. However, limited evidence for locational redundancy is present considering use of the Gerstle River site repeatedly between 9700 and 8000 BP (five components, and probably eight or nine occupations, one occupation in Components 1 and 5; two in Components 2 and 4, and two to three in Component 3). While data are limited for Components 4 and 5, technological organization is similar (tool maintenance and faunal processing) from Components 2 through 5, suggesting similar uses of the site. This may reflect a relatively stable land use system in the Early Holocene in the Tanana basin. The differences in assemblage structure in Component 1 may be due to differences in land use during the earlier period, or may simply reflect local-scale variability in technological organization. Another possibility is that Component 1 may represent a summer occupation, if the wapiti mandible from Block W is associated with Component 1 (see Chapter 6).

Site structural redundancy can be evaluated in terms of the organization of space and recurring modes of depositional sets. Low levels of redundancy might be expected for short term specialized sites like locations and stations, where higher levels of redundancy might be expected for longer term residential sites like residential camps and field camps. The delineation of multiple hearths and relatively similar types of associated depositional sets (including processed faunal remains) suggests that redundancy was present. Given the likelihood of multiple occupations, this redundancy may be characterized as organization of field camps where faunal processing and use and repair of personal gear may occur simultaneously in specific areas.

Compositional redundancy can be evaluated in terms of technological organization. Binford (1978b:354) notes that "the degree that activities will be spatially separated at any one time can be expected to vary with the number of different activities simultaneously performed by different persons." Compositional redundancy can be rephrased as the degree to which depositional sets represent similar to different activity sets. In this context, the systematic use of formal and expedient tools may be approached. Given the short term nature of the occupations in Component 3, it is difficult to estimate compositional redundancy. Certainly depositional sets in Component 3 show considerable redundancy, bifacial and unifacial maintenance and microblade production co-occur in many of the lithic subareas. The analyses provided in Chapters 7, 8, and 10 suggest an initial approach for understanding the use of tools within systemic contexts. These patterns in conjunction with the low variability in site types in the Late Pleistocene/Early Holocene further support an interpretation of high residential mobility.

Storage Facilities

Gerstle River components lack any evidence of storage facilities. No pits, depressions, caches, or structural debris suggestive of drying racks or storage units were found. Additionally, the faunal remains were not discarded in such a way as to suggest discrete areas for drying racks. Elements relating to high meat yields were simply not present; however elements with high marrow yields were exploited and then discarded on site. This pattern meets the expectations developed by Kelly and Todd (1988) about early Paleoindian mobility.

Seasonality

The evidence for seasonality is meager and rather circumstantial, as no juvenile mandibles were found within Component 3. Based on macrofloral data from occupation surfaces (lingonberry berry and seeds, red raspberry seeds, and buds), the wapiti mortality profile, and wind direction based on void areas around hearths, a fall season of occupation is inferred. The faunal assemblage at Broken Mammoth CZ 3 (60% large mammal NISP) is more similar to Gerstle River Component 3 than Broken Mammoth CZ 4 (with only 25% large mammal NISP) (Broken Mammoth data from Yesner 1996), and this also supports a fall season of occupation. No semi-subterranean structures, post-holes, or stone tent rings were observed, through lightweight tents could have been utilized. Considering all of the contextual evidence, a winter occupation is unlikely for Component 3.

Male and female wapiti live apart for most of the annual cycle except for the autumn rut, and the presence of both at Component 3 could be further evidence of a fall occupation. The lack of calves could also support this.

While age at death has been estimated for wapiti tooth rows at Gerstle River Component 3, use of these estimates at the level of month is generally considered unwarranted given the lack of precision (Teresa Steele 2004, Max Planck Institute for Evolutionary Anthropology, personal communication). However, in the absence deciduous or erupting teeth, it is the only faunal basis for estimating seasonality of death. Of the 11 tooth rows, seven (64%) have estimated deaths from July-September, peaking in August. The remaining four tooth rows have estimated months of death from December-January and from April-May. Modern winter conditions in the area include high winds from the ESE that generally keep the area clear of large snowdrifts. Winter occupants would have to contend with severe cold and high winds. While modern moose winter concentrations are located nearby, modern bison concentrate in the area during the summer. Given all of these data, Component 3 occupation(s) likely occurred in the fall, possibly in August.

Ecological and Topographic Location

The Lower Locus is situated in a saddle between a larger hill to the north and a smaller bedrock knob to the south. Such a location would have facilitated observation of the surrounding area in about a 180° view and overlooks a variety of ecological zones, from the well drained south facing slopes, the surrounding lowland poorly drained areas, the edge of a large braided river, to glaciated terrain four km to the south. Fresh water is located currently within one mile, though a seep spring was reported by local miners to be located about one km to the northeast between two bedrock hills. The Gerstle River hill is the last overlook position for a considerable distance to the east north of the Alaska Range, and may have been a convenient landmark for groups traveling along the interface between the lowlands and glaciated highland areas. At about 20 m above the surrounding terrain, groups could be high enough to see for some distance and low enough for quick tactical forays below the site. Furthermore, the presence of the southern hill would offer partial shelter for the Lower Locus area, where people could work and be shielded from view from below and partially sheltered from the wind.

A variety of species are present near the site currently, including freshwater fish, waterfowl, upland bird species, various large, medium, and small mammals including moose, reintroduced plains bison, grizzly and black bears, and caribou, and Dall sheep in the foothills of the Alaska Range to the south (see Chapter 2). It is reasonable to expect that multiple types of prey would be available at least seasonally in the Early Holocene. Certainly, wapiti and bison are evident in the faunal assemblages of Components 3, 5, and stratum Y2. Thus, the location of Gerstle River Lower Locus is suitable for a wide variety of activities, and could be used as a longer term residential base. However, no evidence of such a function was found in any of the components (e.g., house pits, tent rings, secondary refuse areas).

Intersite Dimensions

Group Size and Economic Structure

Important conditioning factors for technological and spatial organization involve social structure. Kinship, gender, age, apprenticeships, and other social categories regularly condition how people use sites within landscapes, and divide space (Anderson 1995; Jochim 1988, 1991; Stevenson 1985, 1991; Boismier 1991; Wobst 1974; Pigeot 1990; Gargett and Hayden 1991; Whitelaw 1991; see also Wobst 1978; Binford 1978a). It is beyond the scope of this dissertation to develop a demographic and/or social model for the Interior Alaskan Early Holocene, but a number of points can be made with respect to the data presented in earlier chapters. Three factors are examined here for Gerstle River Component 3: group size, sexual division of labor, and economic. Other dimensions may be important in developing models of infrastructure (i.e., interrelated technological, subsistence, and settlement system) for this period, such as task scheduling, seasonal patterns of aggregation, band or macroband interactions, territory size, band or macroband size, and kinship systems, but the Interior Alaskan archaeological record has not been used to test these dimensions of variability.

Group size can be estimated on the basis of expectations for high latitude, highly mobile, terrestrial game hunters based on ethnographic correlates. Ethnographic data on twenty-three mobile primarily hunting hunter-gatherer groups in the northwest subarctic were derived from Binford (2001:114-130, Table 5.01). It is recognized that these comparisons, especially Binford's demarcation of collector and forager mobility strategies (1980) may not be totally applicable to the Late Pleistocene/Early Holocene subarctic where bison and wapiti dominate the archaeological record, no aggregate or residential camps are observed, and no storage features have been found. However, the purpose of this analysis is not to apply an ethnographic model to the Upper Paleolithic record, but rather to generate an estimate of group size for dispersed co-residential units for populations dependent on hunting in this region that can be compared with site-specific inferences. According to these calculations, the "mean size of the mobile consumer unit that camps together regularly during the most dispersed phase of the yearly settlement cycle" for 13 mobile primarily hunting hunter-gatherer groups in the northwest subarctic was 20±9 persons with a median of 18 and a mode of 13 persons[2]. Mean sizes of groups camping together during the most aggregated phase of the yearly settlement cycle for these groups was 53±30 persons. Within this sample, percentage of subsistence from hunting was estimated at 65±7, with

[2] Ethnographic groups used in these calculations were Beaver, Dogrib, Hare, Kaska, Kobuk Inuit, Koyukon, Kutchin, Naskapi, Satudene, Sarsi, Sekani, Slave, and Tuchone. Three other mobile subarctic groups were removed given lack of data: Han, Mountain, and Tahltan. Six other subarctic groups were considered by Binford (2001:117) to be sedentary or associated with a central location occupied on a multi-year basis: Carrier, Chilcotin, Holikachuk, Ingalik, Nabesna, and Tanaina, and were excluded from these estimates.

fishing at 28±8. Gathering only constituted 6±4% of subsistence, suggesting that these data may be useful to model early Holocene mobile hunters in Interior Alaska. Using Binford's (2001:117) calculation of estimated mean number of annual residential moves by household units and the sum distance of annual moves (in km) for these thirteen groups yields an average of 15±3 moves per year at a total distance of 395±72 km. The low coefficients of variation for these (18-23) suggest a high degree of similarity in the mobility patterns of these groups. The groups represented at Gerstle River Component 3 are not likely representative of aggregated residential groups given the data presented above, and the number of persons present based on the mode and mean provided above may be around 13-20 for each occupation.

Group size may also be crudely estimated by number of coterminous hearths or artifact densities within a specific site. If all ten hearths are contemporaneous, and each was tended by two to three persons, this would yield a total of 20-30 persons. If Component 3 represents a number of occupations, other estimates can be made. For instance, if the four hearths in Area B were used at the same time (Hearths 1, 3, 5, 9), this would yield an estimate of 8-12 persons. A reasonable estimate given the ambiguities of contemporaneous activity areas would be 12 to 20 persons, especially if more than two wapiti and/or bison were killed, butchered, and brought to the site at the same time. Group size estimates for other components could vary widely. This estimate corresponds with the 12-20 persons per occupation figure from ethnographic data on modern high latitude hunter-gatherers.

Component 3 occupants could represent a number of social unit types, but likely represents a consumer task-group given the limited technological variability and short duration of occupation. This task-group could consist of an all-male hunting party or a mixed foraging group. Given the lack of residential features (house pits, midden-like debris, and storage features) a larger group, such as a local band, is unlikely. While the group could represent both males and females, the lack of domestic items, predominance of weapon maintenance, lack of consumptive marrow processing, differential occupation intensity, and low diversity among tool clusters all suggest that Component 3 materials represents one or more all-male hunting parties. If Areas A, B, C (Feature 12), and D were occupied at the same time, their spatial separation may also reflect separate family units or social distinctions. The metatarsal refit between Areas B and D (Feature 5 and Feature 14) could indicate food sharing between or among domestic units.

A model of group size and economic structure for Gerstle River Component 3 occupations may be used as a basis to speculate about the position that the site played within the larger social and economic system of the occupants (also, see below). An all-male hunting party composed of 12-20 individuals would represent members of multiple families and perhaps lineages, cooperating in the acquisition and processing of wapiti and bison located near the site. This may indicate that another task group composed of women, children, and the elderly may have operated nearby, perhaps within a smaller foraging radius from a residential camp. This hypothesis may be consistent with the short-term encampment reflected at Gerstle River and the removal of high meat-yield animal portions from the site. Though the current state of our understanding of Upper Paleolithic settlement systems and intra-assemblage variability limits robust model building, the patterns observed so far may indicate that early Holocene Interior Alaskan peoples utilized a number of different site types on a seasonal basis, including residential and temporary field camps, specialized lithic reduction locations, flaking and observation stations (and transient camps), and kill locations (see below). One of the more salient patterns from intersite analyses in the Susitna and Tanana basins suggests that sites were more generalized in time periods before 2800 BP, with bifacial projectile points and microblades embedded within structurally complex sites (Potter 2000, 2004b). In later sites, bifacial projectile points are generally found with fewer other tool classes. Significant diversification of site types, represented by recurring tool classes or "structural poses" at different sites, characteristic of cultural systems with higher logistical mobility, appear to be present for this period, where the higher redundancy present in the earlier period reflects higher residential mobility. As argued in earlier sections, high residential mobility characterizes the record during the Pleistocene / Holocene transition. Differences do exist among components in this period, certainly with the variable presence/absence of microblade technology; however, this variability may reflect organization of technology with respect to seasonality, abundance and availability of high quality lithic raw materials, or functional differences between bifacial, organic, and composite implements.

Methods of Faunal Procurement

Hunting strategies used by the Gerstle River Component 3 occupants are likely conditioned by various factors, including ethology of wapiti and bison, season, social organization, and technology. Three elements are briefly examined here, wapiti and bison behavior, inferences derived from faunal data, and technological organization.

The occurrence of bison and wapiti as the major ungulate constituents of most of the faunal assemblages between 8,000 and 12,000 BP in Interior Alaska suggests contemporaneity in similar environments. Wapiti and bison share many characteristics of diet and behavior (Guthrie 1983a). At present, there have been no in-depth investigations of wapiti in the Late Pleistocene in Alaska in terms of seasonal behavior, aggregation, and habitat. Patterns of habitat use, foraging strategies, and seasonal behavior of North American wapiti are derived from summaries in Toweill and Thomas (2004) (especially McCabe 2004; Geist 2004; and Skovlin et al. 2004).

Wapiti are classed as intermediate feeders, subsisting on both concentrates and graminoids (grasses and sedges). They are considered opportunistic, and use ecotones (especially between forest and grassland), utilizing the landscape in a way to maximize efficiency relative to resource patchiness (Skovlin et al. 2004:542). Compared with European red deer, North American wapiti are characterized with more grazing, especially in spring before the rut (Geist 2004:396). Males and females live apart for most of the annual cycle, except for the autumn rut (August-October). The apparent presence of both sexes at Gerstle River could be further evidence of fall occupations. Seasonal migration and frequent local movement is implied by seasonal shifts between grazing and browsing. Deep snow is a limiting factor, and winter habitat could be defined by areas cleared by high or consistent winds. Thus, the area from Gerstle River to the Delta River in the Tanana Lowlands could have been good multi-seasonal habitat, as it forms an ecotone between glaciated highlands to the south and lowland areas to the north and high winds regularly sweep through the area. Populations of overwintering wapiti would make this overall area attractive to highly mobile hunters who did not regularly use storage.

One way to examine relationships between bison and wapiti with respect to human predation is to assess dietary overlap in time and space. Singer and Norland (1994, cited in Miller 2004:441) examined diet similarity of wapiti and bison in Yellowstone. They calculated a diet similarity of 47%, a habitat selection similarity of 75%, and a topographic selection similarity of 57%. Kingery et al. (1996) showed that wapiti and cattle in northern Idaho had the highest mean percentage diet overlap in mid-summer (88±3%, with early summer and early fall overlap between 56-59%), and Hansen and Reid (1975) found that the highest mean percentage diet overlap for wapiti and cattle in southern Colorado was in August (~53%). This variability suggests that seasonal-scale correlations are not defensible. However, wapiti and bison may have occupied similar grass-rich patches in the surrounding Tanana lowlands during part of the summer and early fall. In addition, methods of procurement of wapiti and bison may have been the same, given the similarities between the species in terms of mass and habitat.

Churchill (2002:16) has demarcated five classes of hunting methods for hunter-gatherer populations using thrusting spears, hand-thrown spears, atlatl darts, and bow and arrow weapon platforms, (1) disadvantage (driving into water, etc.), (2) ambush (use of blinds, etc.), (3) approach (stalking, etc.), (4) pursuit (chasing, etc.), (5) encounter (taken as encountered, etc.). Of these types, it is unlikely that disadvantage or pursuit methods would be reflected in an archaeological assemblage characterized as a field camp. As noted in Chapter 6, the kill-site(s) were probably located nearby, perhaps near the Gerstle River, presently one mile distant from the site. No lakes, bogs, or topographic constrictions are located nearby that could place the prey at a disadvantage. Pursuit methods would likely result in the prey capture at some distances from the camp at Gerstle River, and are considered unlikely. No blinds or other features indicative of ambush techniques were found at the site, and the absence of these feature types in the 12000-6000 BP time period in question would suggest that this type of hunting was not common. No evidence of large-scale communal hunting (utilizing drivelines, etc.) is reflected in the archaeological record in Alaska for this time period, with published components having less than eight large terrestrial animals represented.

Mortality profiles for wapiti and bison at Gerstle River Component 3 are prime-dominated, indicating efficient, perhaps long-range (dart) weapons systems and either encounter or ambush strategies (see Stiner 1990, 1994). These profiles, in conjunction with the prime-old animals from Dry Creek Components 1 and 2, could suggest a particular hunting strategy incorporating logistical planning and cooperative labor used for wapiti and bison in the Pleistocene-Holocene transition (see Stiner 1994:307-308). Based on an admittedly small sample, the hunting strategies appear to have been efficient and successful, and given the lack of bone grease rendering and the selection of high marrow yield element portions for breakage, nutritional stress may not have been common.

Given these data, some combination of encounter or approach methods may be reasonable given the local topography, landscape, and local habitats. Presently, bison habitat is located near the site to the northwest, and encounter-based hunting may have been profitable on the Tanana River floodplain. The site itself is located in an ecotone, situated in the Tanana River Lowlands, but with glaciated terrain (moraines, kames, and kettles) located only 4 km south.

This may have facilitated the hunting of multiple species, though the only prey brought to the site were primarily grazers. This suggests that the Tanana River Lowlands surrounding the Gerstle River site location was the site of the kill events.

Economy

While there is disagreement about whether mid-latitude Paleoindian economies were more specialized, relying on large bodied terrestrial mammals, or more generalized, with a broader spectrum of large and small game and plant resource utilization (Hofman and Todd 2001; Haynes 2002; Grayson and Meltzer 2002; Waguespack and Surovell 2003; Cannon and Meltzer 2004), high latitude Paleoindian foragers would be constrained by lack of floral resources (Kelly and Todd 1988). The Alaskan Late Pleistocene/Early Holocene record, while showing use of birds and small mammals (Broken Mammoth CZ4), shows a clear predominance of large game, primarily bison and wapiti. Kelly and Todd (1988) make a strong argument for early Paleoindians (12000-10000 BP) characterized as highly mobile groups with a necessary reliance on megafauna, but generally opportunistic with respect to regional and local variations of specific prey and small mammal, birds, and plant resources. Kelly and Todd (1988:234) note that faunal resource availability is the primary conditioning factor to settlement and mobility patterns, technology, and task scheduling. It is reasonable to suggest that in Interior Alaska, seasonal migrations, local availability and abundance of bison and wapiti would be the principle conditioning factors for task scheduling, though seasonally available waterfowl could also be important. Small game and meager plant resources could be utilized as resources of secondary importance, utilized whenever possible, but insufficient to condition settlement patterns.

Kelly and Todd (1988:234-235) further suggest that the principal Paleoindian strategy for mitigating resource stress (e.g., local or regional variation in prey abundance) was movement into new territories, in other words high residential, logistical, and range mobility. Archaeological implications of this strategy would include (1) relatively undifferentiated technological traditions in different regions (technological conservatism), (2) short term and redundant use of local areas (low diversity of site types, fewer specialized locations or stations), and (3) lack of long term storage facilities. Residential camps should be relatively ephemeral and short-term and regional populations should be very low. The extant archaeological data in the Alaskan Interior for this time period are consistent with these expectations, and Gerstle River data provide additional support for this model. This system was apparently operative until about 2800 BP, when sites were more varied (Potter 2000, 2004b).

As shown in Chapter 6, evidence of broad spectrum foraging or a generalized economy is not present in Gerstle River Component 3. The mortality profiles for wapiti and bison suggest efficient hunting strategies, and the lack of bone grease rendering and the marrow extraction in calcanei and astralagi suggest that nutritional stress was not present. While diet breadth may have included seasonally available waterfowl and small game may have been utilized, the Early Holocene record in Interior Alaska suggests strong focus on large terrestrial mammals. Residential mobility is considered very high given the patterns generated from faunal and lithic analyses, and the near total absence of element portions associated with high meat yields, including thoracic and cervical vertebrae and ribs would indicate that the hunting strategies were efficient and generally successful, with little nutritional stress in evidence.

Another avenue for assessing economy is examining food yield per person from faunal MNI estimates. Using food weights for bison and wapiti derived from McCabe (2004:151, Table 12[3]), estimates of food yield per person for Component 3 faunal remains have been calculated. Assuming that all of the animals present (total artiodactyl MNI = 8) were utilized at roughly the same time, a total of 2572.2 kg of food was potentially available (1296.0 kg from wapiti [MNI=5], 1276.2 kg from bison [MNI=3]). Assuming an annual animal food consumption rate of 1.4 kg/day (derived from McCabe 2004:149-151 for pre-contact Native Americans), an estimate of 1837 person/days may be represented at Gerstle River Component 3 in one or more occupations. This estimate of food yield, assuming a single occupation, may have sustained 10 people for 184 days, 20 people for 92 days, 25 people for 74 days, 50 people for 37 days, and 100 people for 18 days. These estimates suggest that multiple occupations are likely present, but even assuming four occupations (one for each lithic area), the large amount of available meat suggests that Gerstle River Component 3 may represent an extractive location where animal portions were processed for use by a larger population in a residential camp setting, perhaps at some distance from the field camp. While these data cannot be used to definitively estimate group size, they do point to the processing of larger amounts of food than would be necessary to sustain a small, highly mobile population. This strongly suggests that this site functioned as a field camp where

[3] McCabe (2004:151) calculates food yield as "90% of dressed carcass weight (minus most bones), plus 60% of viscera."

extractive tools were maintained and game was processed for further transport to a residential base camp. If this is the case, this supports the hypothesis of an all-male hunting party or parties.

Storage was not observed at Gerstle River Component 3. Anatomical portions may have been dried on-site, but no evidence for this is present in the form of open areas devoid of lithic clusters and broken bone or remnants of drying racks. Given the short duration of the occupations, it is suggested that storage or processing of meat for longer terms did not occur, or if they did, they may have occurred at a residential camp where the high meat-yield animal portions were removed. The inferred high efficiency and success of the hunting strategies suggests that nutritional stress or other stress that might lead to increased storage was not a primary factor in forming the faunal assemblage.

Settlement System

Guthrie (1983a:268-273) suggested a settlement system for Late Pleistocene populations in the Nenana valley, composed of a central base or residential camp and outlying spike camps where processing of game for transport to the base camp, various tool maintenance, and other tasks occurred. Using this framework, Guthrie considered Dry Creek Components 1 and 2 to be spike camps. In fact, all components in this period would be considered spike camps or work stations depending on the variable presence/absence of faunal remains and features. The proposed base camp had features not present in the spike camps, such as storage features (caches) and drying racks to allow logistical flexibility, domestic items, and presumably semi-subterranean features similar to those at Ushki-1 to allow shelter through the winter. Unfortunately, no archaeological materials resembling such a camp have been found to date. Guthrie (1983a:269) suggests that these camps would be located near suitable water sources, sheltered from elements, and have available fuel for fires.

Numerous surveys have been conducted in Interior Alaska, and with the growth of cultural resource management (CRM) over the last 35 years, a wide variety of environments have been sampled (see Potter et al. 2002). To date, no archaeological components have been found reflecting the base camp model. This absence could be due to the location of base camps along rivers in valley bottoms (Yesner 1996) and the subsequent destruction through river channel changes. Another possibility is that open-air short-term camps were used as residences, and early prehistoric populations may have been more mobile than earlier thought (see Mason et al. 2001:542). The faunal data from Gerstle River Component 3 suggest that meat-bearing elements were removed from the kill site or from the Gerstle River site, and marrow-bearing elements were broken and discarded at the site. The missing elements may have been part of a storage system, may have been dried and consumed elsewhere, or may have been transported to a base camp as described by Guthrie (1983a). However, it should be noted that all of the criteria established by Guthrie (1983a:269) regarding suitable base camp locations is met by the Gerstle River site, including substrate suitable for excavation of semi-subterranean dwellings. The fact that no residential characteristics of residential camps were found suggests that these criteria are necessary but insufficient for discrimination of non-residential field camps and residential camps.

Reasonable expectations for residential base camp characteristics would include relatively high diversity of tool types, high number of lithic raw material types, and features relating to dwelling structures (e.g., semi-subterranean houses, tents) (Binford 1980; Carlson 1979). The dwelling structures observed at Ushki 1, level VI (~10600 BP) (Goebel and Slobodin 1999) are the only residential dwellings known for the Late Pleistocene or Early Holocene in Beringia, and can serve as useful models. These dwellings were divided into three types: Type 1 semi-subterranean house with centrally located rock-lined hearths and narrow entrance tunnels or corridors inferred to be winter dwellings; Type 2 surface house with centrally located rock-lined hearths without entrance tunnels (somewhat smaller than the first houses) inferred to be summer huts contemporaneous with the Type 1; and Type 3 large, irregularly shaped charcoal smears inferred to be dwelling structures from earlier habitations (Dikov 1977, cited in Goebel and Slobodin 1999:133-134).

To date, no comparable structures are known for Alaska in this time period. Goebel and Powers (1989:15) have suggested that circular spatial distributions of artifacts around centrally located unlined and clay-lined hearths at Walker Road Component 1 may be evidence of one or two tent-like surface structures, but no structural remains similar to Ushki 1 levels V, VI, and VII have been found. Analysis by Higgs (1992; 1994) shows extensive lithic refits between all three concentrations within Walker Road, suggesting contemporaneity among the areas, indicating that they may not have been produced within structures.

Other site types can be tentatively inferred from the information present at Gerstle River Component 3 and other Late Pleistocene/Early Holocene components in Interior Alaska. One or more kill locations were likely located near Gerstle River during the period between 9700 and

8000 BP, as evidenced by the faunal analysis. Little Delta River #3 (XBD-167) may be interpreted to be a specialized lithic reduction station, with a stratigraphically associated radiocarbon date of 9920±60 BP (β-123331) (Higgs et al. 1999). Artifacts recovered within two 1 x 2 m test pits revealed 3290 flakes, seven biface preforms, one pointed uniface, one pebble tool, and three tested chert cobble fragments. The lack of finished tools, the proximity to the Little Delta River, large size of the flakes, and the presence of biface preforms and tested cobbles suggest that chert river-washed cobbles were recovered from the Little Delta River and initially reduced on site. No microblades were recovered at this site. Healy Lake Village Levels 6-10 may represent a longer-term field camp reflecting different depositional sets than those at Gerstle River Component 3, given the higher artifact diversity (Cook 1969). The presence of numerous scrapers in addition to bifaces and projectile points could reflect a more integrated field camp representing both male and female activity areas. Lithic raw material sources like Type A obsidian in the Wrangell Mountains or Landmark Gap chert would result in specialized quarry work stations. Site function must be understood in the context of the entire settlement system, not as a pristine technological representation of a specific "culture." Archaeologists are at the initial stages of understanding settlement systems for Late Pleistocene/Early Holocene populations, and the development of detailed intra-site studies for sites that may reflect different aspects of a settlement system would is critical. This analysis of Gerstle River Component 3 is a contribution to this effort.

General Conclusions

The excavations at Gerstle River Lower Locus from 1999-2003 have revealed five archaeological components and at least one earlier paleontological assemblage. Paleontological specimens consisted of horse, saiga antelope, wapiti and/or moose, bison, caribou, bear, and small mammals, some likely dating to the Holocene, but the horse and saiga at least dating to the Late Pleistocene (c. 15000 BP, c. 18000 cal BP). No evidence of human association with these early remains was discovered.

The first human occupation at the site (Component 1) co-occurred with the first stable soil of the Holocene or shortly thereafter, around 10000 BP (~11250 cal BP). This component is characterized as a short-term flaking station with a relatively limited array of lithic tool classes (projectile point, biface, burin spall, and modified flakes) represented by a few lithologies, dominated by green chert, and few faunal fragments. The remains are partially disturbed by post-depositional colluvial slopewash, though the stratigraphic integrity of the component is intact.

Component 2 consists of two activity areas, each associated with a hearth, both yielding contemporaneous radiocarbon dates (~9500 BP, ~10800 cal BP). Microblade production and on-site inset replacement occurred, with little evidence of inset removal and discard and use in an activity area, though overall lithic activities are considered less intensive than Component 3 given lithic density comparisons. While associated faunal remains were observed, these are too meager to elicit speculation about faunal processing.

The archaeology of Component 3 is described in detail in the preceding section. Component 3 consists of a wide variety of lithic materials including formal bifacial and unifacial tools, expedient tools made on flakes and to a lesser extent blades, and fully developed microblade technology, with conical and subconical microblade cores, core tablets, rejuvenation flakes, and used and unused microblades. Ten hearth features were discovered to date, and all but one (Feature 18) yielded contemporaneous radiocarbon dates (~8900 BP, ~10000 cal BP). Feature 18 may relate to an earlier occupation dating to 9100 BP (~10200 cal BP). Multiple individuals of wapiti and bison were recovered in direct association with the features and lithic items. Post-occupational and post-depositional taphonomic processes did not drastically alter element composition or spatial patterning of the faunal assemblage. Differences in average faunal weight, shaft weight, bone type, %burned bone, skeletal unit type, and articulation were found among spatial clusters of faunal remains, and are accountable through a spatial model of processing, faunal trajectories, and transport decisions. Wapiti and bison carcass portions were treated in a similar fashion. Carcass portions were brought to the site from one or more off-site kill sites, brought to a central staging area, element groups (primarily lower and upper limbs) were removed from the carcass and processed for marrow around hearths, likely as a result of mass marrow processing rather than individual consumptive marrow processing. Another group of element groups (primarily meat and fat associated with ribs, cervical, and thoracic vertebrae), were likely prepared for transport, removed from the site, and taken to a residential base camp. Component 3 functioned as a temporary field camp where large mammals killed nearby were processed with the aid of expedient tools and curated toolkits (personal gear) were maintained (exhausted/broken tools were discarded, microblades produced, and bifaces and unifaces maintained).

Component 4 consists of two activity areas, one associated with a hearth dating to ~8700 BP (~9700 cal BP). Both areas are very short term flaking events, dominated by one lithic raw material type. Tools in one activity area consist of one burin and eight modified flakes (Area H). Large mammal remains (82 g) were associated with the hearth and a modified blade in the other activity area (Area G). This hearth and associated faunal remains were very similar to those in Component 3.

Component 5 consists of a diffuse unmodified flake scatter only partially excavated to date. While there is no directly associated radiocarbon date, stratigraphic bracketing dates suggest an occupation dating to ~8000 BP (~8900 cal BP).

Two other components are present at the Upper Locus, Component 6 with stratigraphic bracketing dates yielding an estimate of ~5900 BP (~6700 cal BP) and Component 7, dating to ~3800 BP (~4200 cal BP).

Discussion

To avoid post hoc accommodative arguments, I have focused on analyzing the spatial patterning from many different perspectives and dimensions. The investigation of interrelationships among these dimensions resulted in identification of patterns and insights into basic organizational properties and has provided a dataset useful for testing future models derived from experimental, ethnoarchaeological, and other middle range approaches.

The most important result of this investigation is that patterns of technology and technological organization can be more highly resolved when incorporating spatial analyses and situating the technological analysis within a contextual framework of geoarchaeological, zooarchaeological, and temporal patterning. Certain dimensions of variability can only profitably be examined when controlling for spatial variability within a site. For example, microblade technology, often seen as representing a limited or unidimensional set of behaviors, is shown to be structurally complex, with considerable patterned variability at various scales of analysis, including material type, modification type, lithic cluster (inferred flaking event), subarea, area, component, and region. Technological and economic analyses conducted primarily at the level of component or site may create ambiguous or misleading results.

These analyses have shown that microblade production and use occurs in a wide variety of contexts, in conjunction with bifacial and unifacial tool manufacture, maintenance, and use, expedient tool manufacture and use, faunal processing, and perhaps organic tool manufacture. Microblade use was clearly situated within an organized technological system, and exploring which factors can be expressed in microblade patterns will be critical in understanding microblade use throughout the Late Pleistocene and Holocene periods in Alaska. A number of avenues are proposed and explored in this research at the level of attribute, artifact, cluster, area, component, site, and region. A system for classifying microblades on the basis of modification type was developed in Chapter 7. Multivariate examination of variability in microblade attributes revealed patterns that could be observed only at specific scales of analysis. For instance, no bimodality was observed in proximal width of complete and proximal specimens indicating preferential segment deletion at the level of component, but bimodality was observed at the level of material type and lithic cluster. Microblades were produced with relatively narrow tolerances with respect to proximal width and thickness; material type and quality did not make significant differences.

Microblade groups were demarcated on the basis of total weight, percent modified, and presence of core parts to infer local material production vs. exotic and local material discards. These patterns were robust across component and material type, suggesting these may be useful models. Another model based on a variety of attributes distinguished microblade clusters representing microblade inset production, inset replacement, and inset discard. A review of composite and slotted tools from Siberia, Alaska, and Yukon Territory revealed a wide variety of forms, materials, and presumed function. Comparisons with Dry Creek Component 2 clusters revealed patterned variation in associated tool classes, interpreted as either core manufacture vs. core maintenance/microblade production or the variable presence of early stages of biface reduction. The differences between microblade cores and microblades frequencies may be due to differences in lithic raw material availability or different stages in the microblade core manufacturing – reduction sequence.

Another model of microblade groups was constructed based on patterning at the level of cluster or flaking episode. Two main groups were distinguished, one representing inset removal and discard, the other representing microblade production, largely paralleling the production/inset groups mentioned above. The microblade production group was also further demarcated on the basis of absolute frequency of microblades, proximal width, percent modified microblades, differences in segmentation, and differences in modification type. Groups may reflect differences in inset production vs. inset replacement (i.e., production of insets for new slotted implements vs. production of insets for replacement within used slotted implements).

From these data, spatial models of microblade use and variation were described at the level of Subarea and Area. Inferred activities included inset removal and discard, use within an activity area (both lateral and end modified microblades), inset replacement on-site, and inset production for new composite implements. The spatial organization of the component was described on the basis of these distributions, and spatial relationships among bifacial and unifacial tool maintenance and use, expedient tool use, and faunal clusters.

At a regional scale, the temporal distribution of microblade technology in Interior Alaska was reviewed. The single dominant pattern is presence of microblade technology from the earliest components to some of the latest. The presence of wedge shaped microblade cores in Cultural Zone 1a at Broken Mammoth (dated to 2000-2800 BP) shows continuity of core morphology (Holmes 1996), though tabular and conical forms are still found in the late Holocene. There can be no doubt of the occurrence of microblade technology at every time period during the occupation of Interior Alaska until around 1000-800 BP. A series of tests showed that the apparent relationship between non-microblade assemblages "preceding" microblade assemblages cannot be distinguished from sampling error. Certainly the results indicate that archaeologists must take into account the small sample sizes of assemblages during this period. Since microblade clusters co-occur within sites for which large excavation areas and large assemblages are available, and sites with and without microblades are coterminous in the same region, microblade use is likely conditioned by site organizational and technological organizational factors. Patterns of microblade variability were described and explanations offered in Chapters 7, 8, 10, and above. The use of microblades or wedge shaped microblade cores as a temporal or ethnic diagnostic is unwarranted. However, understanding how microblade technology varies within and among sites may be a critical first step in understanding a variety of spatial and technological organizational factors affecting site structure. Some of these factors are sketched above, but a more detailed and robust analysis requires intra-site analyses at multiple sites in different regions and in different time periods.

Several models for the explication of microblade technology, and its changes through the Holocene were described and tested in Chapter 7. These included microblades used as inset within composite implements that functioned in a similar fashion to bifacial projectile (dart) points, but were distinct due to (a) association with specific cultures or time periods, (b) differential access to lithic raw materials, or (c) specific prey species. Another model examines the possibility of distinct functional differences of composite implements. The patterns of various evidence are consistent with microblades functioning as side blade insets within a variety of implements (knives, spear points, dart projectile points) and end blade insets used for delicate cutting, scraping, piercing or perforation. Blank selection attributes for each function were described and related to the observed patterns at Gerstle River. The very real problem of interpreting two different projectile systems (composite and bifacial), or three if organic non-slotted points are included, is addressed through a model of microblade use within detachable composite thrusting spear points and dart points for use with atl atl/dart projectile systms, but possibly more associated with the former.

Modified flakes were also examined at various levels within Component 3, and distinct patterns emerged. Two distinct groups of modified flakes were demarcated on the basis of modified edge angle and thickness, and four groups were defined on the basis of modification type, edge angle, and edge shape. These groups may be useful within the framework of future usewear studies, and their discrimination shows that expedient flake and blade tools should not be ignored or lumped together. For example, burins and flakes with burin-like damage may be distinct from a technological standpoint, but they are similar from a morphological and perhaps functional perspective. Burin spalls may be associated with both creation and rejuvenation of flake burins, but also with unifacial tool resharpening given the clustering of burin spalls with unifaces (Chapter 8). These results suggest that archaeologists should have multiple models of assemblage structure in mind when describing lithic assemblages, especially for expedient tool forms.

The relative lack of organic tools at Gerstle River may result from various sets of conditions. The two principle conditions are taphonomic and cultural. First, it is possible that the remains of organic tools were there but that they did not survive or that they were degraded to a point where they could not be identified. However, the presence of bone fragments with low density, the presence of a worked ivory point, and the lack of antler or worked bone in Component 3 suggests that taphonomy may not be the primary factor. The second condition could be cultural. Populations may have (1) heavily curated organic artifacts, (2) discarded them in other settings, or (3) not used organic artifacts as heavily as some have assumed. We cannot discriminate among these latter alternatives at this point, and they should be kept in mind when interpreting the role of organic artifacts within these technological systems.

A variety of independent lines of evidence were used to distinguish a palimpset of two occupations within Area C. The high resolution radiocarbon dating analysis showed the possibility of an occupation separated by about 100-200 years in this area. A number of occupation scenarios were described and evaluated based on radiocarbon dating, faunal patterns, ethnographic patterns of hunter-gatherer site use and re-use, k-means cluster analysis, lithic raw material distributions, lithic refits, inferred wind direction, and tool clustering.

While the focus of this dissertation has been on various intra-site dimensions of analysis, several conclusions and hypotheses relate to broader regional analytical scales. Microblade technology is clearly an important aspect of prehistoric technological systems throughout the Late Pleistocene and Holocene periods. The data and analyses presented in this dissertation and results of intersite variability studies (Potter 2000, 2004b) suggest that we need a critical review and evaluation of current models for cultural continuity and change in Interior Alaska. When microblade technology and co-occurring burins are removed as the sole criteria of cultural tradition delineation, and intersite variability is assessed relative to number of end scrapers, a demarcation of Denali and Nenana is less defensible. At the level of tool class, non-microblade clusters in Dry Creek Component 2 cluster closely with clusters in Dry Creek Component 1. Burins and microblade technology are tightly co-occurring, forming a discrete tool group that can create ambiguity when used to construct cumulative graphs of tool classes of different assemblages (e.g., Goebel 1990). The temporal demarcation of non-microblade and microblade assemblages in the Late Pleistocene is also not substantiated when all available components are examined (see Chapter 8).

An important implication of the close spatial association of microblade production areas and non-microblade tool maintenance areas is that these two technologies cannot be separated as distinct cultural diagnostics reflecting different cultures or components on a site where both occur in insecure contexts, such as a surface or near-surface site. For instance, an argument has been made that the microblade technology at the Mesa site represents a distinct culture from the producers of the Mesa bifacial projectile points on the basis of localization and use of different material types (Bever 2000:122-131; Kunz et al. 2003). However, microblades are generally deposited in small discrete clusters (see Potter et al. 2000a and above). An alternate hypothesis of association of these materials at Mesa is supported by the spatial locations of microblade technology superimposed over concentrations of Mesa Complex artifacts in Subarea A1/2 and A5, and the presence of microblades throughout all areas of Locality A (Kunz et al. 2003). It is unclear if microblades were also found in Locality B, East Ridge, or Saddle given the extant data. Raw material was considered to distinguish microblade and non-microblade components at Mesa (Bever 2000:126-129), however ~33% of the microblade technology were made on local materials, the predominance of non-local raw materials may be related to differential curation. From sites near Landmark Gap quarry in the Tangle Lakes, biface manufacture was predominant near the source (see Mobley 1982; and above), though a number of microblade sites occur very near to this source in the Early Holocene. In addition, the fluted biface was manufactured from the same exotic raw material as many of the microblades, and Bever notes that though it is similar in morphology to Mesa points, the only difference is the fluting (Bever 2000:129). Finally, Bever (2000:131) notes that a Type II (or B) biface was broken and several blades or burin spalls were driven off using the broken facet as a platform, implying a later occupation. However, Bever (2000:143) notes that Type II bifaces (n=10) were manufactured in a different fashion from the projectile points (n=131). An alternate explanation is that Type II bifaces are associated with microblades.

It may very well be the case that microblades are not a part of the Mesa Complex, and I do not claim here that there is incontrovertible proof that microblades and bifacial projectile points were used by the same population at that site. However, my point here is that *a priori* assumption of separation of microblade and bifacial materials is unwarranted. Certainly, assuming temporal priority of non-microblade materials is also unwarranted.

A more constructive avenue of inquiry for Late Pleistocene / Early Holocene Alaskan sites entails detailed analyses of locational, topographic, ecological, and geomorphic variability with respect to lithic assemblage characteristics. One such approach may involve associations of components with relatively stable vegetated surfaces or aeolian depositional surfaces.

The association of Gerstle River components with aeolian silt deposition and lack of association with stable surfaces is intriguing. Mason et al. (2001) suggest an inverse relationship between population size or density and warmer climates during the period between 13500 and 7000 cal BP. They found the highest number of occupations at ~8500 cal BP, which correlates with the Mesoglacial period. Mason et al. (2001:540-542) hypothesize a link between caribou population increases and colder, more arid conditions and Denali success. However, an analysis of the calibrated ages associated with the 37 components described in Chapter 8 dating between ~15000 – 8500 cal BP, reveals an increase between 13000 – 11500 cal BP, peaking at ~12250 cal BP rather than during the later period. Certainly, some of the occupation constructions are questionable: (1) the inclusion of four occupations within Dry Creek Component 2, one dating to 7985±105 BP based on a single outlying date on natural charcoal, (2) two occupations at Broken Mammoth CZ 2 where one of the dates, 7200±265 BP, was on a hearth also dated to 7600±140 BP, similar to the second presumed occupation at 7700±80 BP. In any event, I suspect that we lack sufficient samples at high enough resolution to test competing paleodemographic models. However, the relationship between a colder, more arid climate, correlating with more steppe-like conditions and Interior Alaskan populations could be partially explained by increase in bison and wapiti habitat, though a reliance on caribou, postulated by Mason et al. (2001:540), is not substantiated by extant faunal assemblages (see Chapter 6). At least in the Gerstle River area, the clear association of each component with a massive loess and the absence of any occupation associated with stable (presumably forested) surfaces could suggest consistent patterned use of the surrounding landscape through the early part of the Holocene.

The results of various analyses presented here also have implications for how we conduct archaeological research in Interior Alaska. We should give careful attention to our definition of appropriate units of analysis when examining technology, economy, and spatial organization. I argue that analyses and interpretation should be conducted at the level of clusters where definable, rather than components as a whole. The identification and possible demarcation of palimpsets should be a high priority. Multiple models of site occupation scenarios are constructive and can lead to new interpretations and identification of patterning when tested against different data classes. Cultural chronologies, while important for organizing varied collections, should be used as a particular (and not the only) frame of reference, in conjunction with expectations derived from ethnographic and experimental work, when developing and testing models describing or explaining variability in use of tools, sites, and landscapes. The definition of components and occupations should also use multiple lines of evidence and robust testing of alternate configurations of occupation.

The data and analyses presented here are also relevant for broader issues of the entry of Siberian populations into the New World around 12000 BP. The near ubiquity of microblades in Siberia, the re-dating of Ushki Level VII (see above), and the association of microblade technology with the earliest Beringian occupations (Swan Point CZ4a and CZ4b), all underscore the necessity for a better understanding of how microblades were used within technological systems. The transition from Pleistocene to Holocene in the northwestern part of North America saw continued use of microblades. The transition from early gallery forests to the modern boreal forests saw continued use of microblades, though some changes in prehistoric settlement systems and technology are apparent. Clearly, the conservatism exhibited by this technology through different climatic oscillations, environmental regimes, and faunal assemblages is an extremely important fact, and the patterns identified and the models offered here to explain some of the variability may be useful contributions to orient our questions at the scale of individual activity areas or depositional sets, components, sites, Interior Alaska, and northwest North America.

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APPENDIX A: HISTORY OF INVESTIGATION (1976-1996)

The Gerstle River site has been investigated by several researchers since its discovery in 1976 by Charles Holmes (Holmes and Dilliplane 1976). This appendix describes each investigation at this site and the resulting artifacts, features, radiocarbon dates, and interpretations as presented in their reports. The purpose of this detailed description is to provide documentation for Upper Locus investigations, given that no comprehensive site report exists for the 1983 and 1985 excavations, though testing reports are available for the 1976, 1977, and 1996 seasons (Holmes and Dilliplane 1976; Rabich and Reger 1978; and Holmes 1998a). A timeline of investigations is provided in Table 1.1 and details of the 1999-2004 investigation is presented in Chapter 1.

1976 Discovery and Testing

The earliest archaeological investigation at the Gerstle River site occurred in 1976 during an archaeological survey of various localities along the Alaska Highway by Office of History and Archaeology (Alaska Division of Parks) personnel, led by Charles Holmes (Holmes and Dilliplane 1976). The Gerstle River site was identified by Holmes within the Gerstle River Quarry ADOT&PF material source (MS62-3-073-2, F-025772). Artifacts were found eroding out of an exposure at the edge of a bulldozed trail at the Upper Locus (Figure A.1). Three test pits were excavated at the top of the Upper Locus in an undisturbed area, one of which (TP #1) produced a number of lithic items. According to the profile in Holmes and Dilliplane (1976:VII-10), the artifacts were associated with the next to lowest reddish oxidized zone with a questionable association of artifacts with the lowest reddish oxidized zone. In addition to these three test pits, which are not plotted, the 1977 excavation report notes an area of "1976 Excavation" which corresponds to approximately 50 cm of the Upper Locus southern edge of disturbed sediments (Rabich and Reger 1978:I-15). There are no photographs or mention of artifacts or fauna of the Lower Locus in the 1976 report. Holmes later noted that "a few surface artifacts and animal bones were found on the lower hill [Lower Locus], clearly in a disturbed condition, and some flakes and bones were found on the lower part of the bull-dozed trail. The

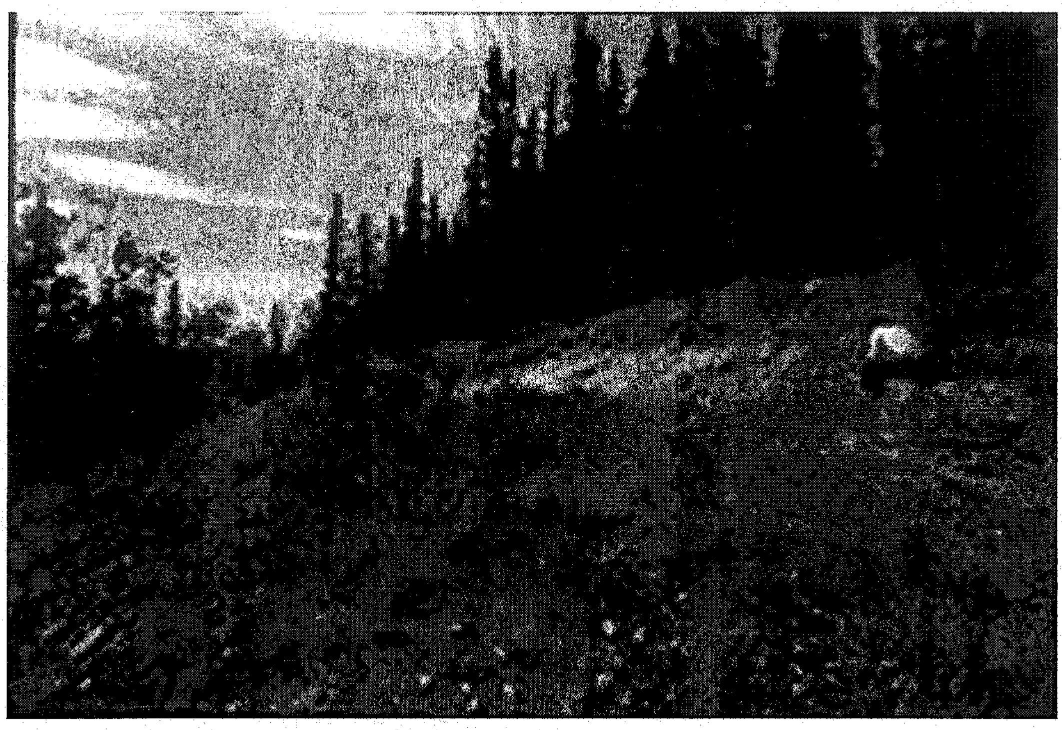

Figure A.1 Cat trail and area of disturbance in 1976 at the Upper Locus, view west (photo courtesy of Chuck Holmes).

lower hill and trail were not further investigated because it appeared that these areas were too disturbed to have archaeological integrity" (Holmes 1998a: 4).

Holmes (1976:VII-7) noted "numerous stone chips and flakes of several lithic types as well as an occasional retouched or utilized flake tool" and "[o]ne microblade medial segment" were recovered. In a later report, artifacts found in 1976 at Gerstle River consisted of 348 flakes (of rhyolite, basalt, chalcedony, and chert), one lump of red ochre, one .22 caliber cartridge, 2 unifacially retouched utilized flakes, 1 endscraper fragment, and 3 microblades (Rabich and Reger 1978: I-5). These artifacts are described as located at both the upper and lower loci (1978: I-5).

The collection was apparently collapsed into the 1977 collection from the site accessioned to the University of Alaska Museum (as UA77-55). The 1976 collection was apparently loaned to Japanese researcher Yoshinobu Kotani in the 1980s. After the efforts of the author and UAM Ethnology Curator Molly Lee, these collections were finally returned to UAM in 2001. However, the associated hand-written catalog does not list any 1976 materials. The exact present location and fate of the 1976 materials is unknown, but most likely they reside in Japan. A catalog of the 1976 materials was obtained by the author. Significantly, Holmes noted that Gerstle River was a potentially significant site and recommended that no further quarrying be done until an archaeological clearance could be obtained (Holmes and Dilliplane 1976:VII-12).

1977 Excavation

After the brief initial testing in 1976, Holmes returned to Gerstle River Upper Locus (defined in the 1977 excavation report as "XMH-246"), and with T. L. Dilliplane and Joyce C. Rabich, excavated approximately 12 m^2 between June 8 and July 4, 1977, identifying two components in stratified context (Rabich and Reger 1978:I-1). Two additional areas with archaeological materials were identified, *Quarry A*, "found on a terrace midway between the first site and the base of the hill" and *Quarry B*, "discovered along the trail approximately 150 m. (500 ft.) west of XMH-256 [sic]." Therefore, Quarry A can be considered coterminous with Gerstle River Lower Locus, and Quarry B with the area just below the Upper Locus (see Figure 1.4). The 1977 excavation consisted of eight one-meter units along the edge of the disturbed southern edge of the Upper Locus and ten complete one-meter units adjacent to the north (Figure A.2).

Two components were found, the upper one associated within the mottled loess above the uppermost oxidized layer (Rabich and Reger 1978: I-4), or Y1 (Potter 2002). This component consisted of 43 flakes (of chert, chalcedony, and obsidian), one endscraper and three utilized/retouched flakes. A radiocarbon date of 4120±170 BP (Gx-4950) was obtained at 24-32 cm below the surface within soil unit 2 ("mottled loess"), and a few cm below the upper component (Rabich and Reger 1978: I-7). This date, at the lower limit of Y1, appears to be a good lower limiting date on the upper component (see Chapter 5).

The lower component(s) were associated with the two lowest oxidized layers, correlated with R3 and R4 (Rabich and Reger 1978: I-4), or R3 to R4 (Potter 2002). The excavators note the possibility of two components, but their distribution overlaps (Rabich and Reger 1978: I-4). Given the relative vertical proximity of the middle and lower components observed by Kimura et al. (1989) (see below), it is likely that Rabich and Reger recovered artifacts from both the middle and lower components of Kimura et al. (1989) in 1977. Artifacts from the lowest oxidized stratigraphic layer (correlating perhaps with Component 3) consist of 743 flakes, 17 microblades, one core/burin, and four fractured cobbles. Artifacts from the middle oxidized stratigraphic layer (correlating perhaps with Component 5) consist of 138 flakes, one modified flake, and seven microblades.

Additional cultural material was recovered in disturbed surficial contexts from Quarry A and Quarry B. Three flakes, one end scraper (short-axis beveled flake), one microblade, a rectangular biface, along with a caribou (Rangifer sp.) left proximal phalanx and a moose (*Alces alces*) right upper molar were found on the surface at Quarry A (Lower Locus). A primary burin spall, and caribou right radio-ulna and moose right innominate were found on the surface at Quarry B (Upper Locus) (Rabich and Reger 1978: I-6).

The 1977 Gerstle River collection was accessioned to the UAM (UA77-55-001 through 109), and subsequently loaned to Y. Kotani. These materials were not returned at the due date, and an extension was allocated until 1995. With the assistance of UAM Curator of Ethnology Molly Lee, some of this collection was recovered, which again is housed at UAM. Unfortunately, the faunal remains appear not to have been returned with the lithic collection.

Figure A.2 1977 excavation at the Upper Locus, view north-northwest (ADOT&PF photograph).

1983 Excavation

Very little is known about the 1983 excavation at the Gerstle River Upper Locus. The principal investigator was Yoshinobu Kotani, then an independent researcher testing a number of central Alaskan sites in 1983 and 1985 (Gerstle River, Walker Fork) (Kotani 1983; Kotani et al. 1984). No known record of their work at Gerstle River is published or written, except for a brief discussion in a 1989 article on flake replication written by Kimura, Kotani, and Nishimoto (1989) for the Japanese Museum of Ethnology. The researchers excavated a 4 meter by 5 meter block labeled "A-Grid", immediately north of the 1977 excavation (Figure A.3) (Kimura et al. 1989). Excavations occurred from July 13 to August 5, 1983.

Three components were defined, and Kimura et al. (1989) notes that one projectile point basal fragment, two secondary processing flakes of obsidian, and some other flakes were from the upper component (correlated with Component 7), associated with stratum Y1 (Potter 2002). One microblade was recovered from the middle component (correlated with Component 5), associated with stratum Y3 (Potter 2002). One microblade core, 40 microblades, and 160 flakes were recovered from the lower component (correlated with Component 3), associated with stratum Y4 (Potter 2002). The artifacts in the lower component were found primarily on the southern side in three concentrations. Apparently, faunal remains were found *in situ* according to the field catalog, though no discussion of faunal remains is presented in Kimura et al. (1989). Two radiocarbon dates were listed in the 1983 catalog, 7660±310/330 BP (DIC-2868), from "5th yellow", within the NE quad of unit N7, W13, with a depth of "L. –21 cm" and 6400±370/380 BP (DIC-2869), from "3rd Red", within the NE quad of N6, W14, with a depth of "L. –10 cm." The placement of the 7660±310/330 BP date is consistent with Kimura et al. (1989: Figure 3) and Kotani's generalized profile of the A-grid (Kotani n.d.), however Kotani places the 6400±370/380 BP date with "2R", not the "3rd Red" layer. This latter date is not mentioned at all in Kimura et al. (1989).

The 1983 Gerstle River collection was accessioned to the UAM (UA83-52-001 through 329) by the State of Alaska archaeology permit, however the collections never reached UAM. Kotani took the collection to Japan before it could be formally accessioned. As described above, some of these materials were returned in 2001. However, no faunal remains were returned with the lithic collection.

1985 Excavation

In 1985, researchers under the general direction of Yoshinobu Kotani[1] excavated 51 m^2 from the Upper Locus (A, B, C, D, E, F, G, and H Grids) recovering thousands of artifacts, faunal remains, and identifying at least two probable hearth features. A 4 m x 5 m block was excavated immediately west of the 1983 work (A-grid) (Figure A.3), and a trench (1 m wide) extending to the east was excavated (B-grid). Additional 1 m x 2 m test units were excavated downslope to the east (C, D, E, and F-grids). A 3 m x 4 m block was excavated on a small (4 m x 5 m) knob downslope and east of the main excavation, designated G-grid (Figure A.4). A small test pit (H-grid) was placed on the top of the knob to the north, overlooking the A-grid. Excavations occurred from July 23 to August 9, 1985.

The only report on these investigations is a Japanese-language report published by the Japanese Museum of Ethnology in 1989 (Kimura et al. 1989). The paper only details lithic artifact distributions for part of the 1985 excavation (A-grid, see below), with minimal information on artifacts recovered in 1983, and no data on the faunal remains. No features were mentioned in the paper, though the original plan-views of several excavation units illustrate concentrations of bone, charcoal, and artifacts. It is possible that hearths were excavated in the 1985 excavation of A- and G-grids, as several scatters of large cobbles labeled "debris" and shaded areas labeled "carbon" were noted in the field plan maps. Faunal remains were also noted on the maps and in the artifact catalog, but no information regarding the faunal assemblage was provided in the report.

Artifacts were recovered from all three components identified in 1983; these are listed in Kimura et al. (1989) as one flake from the upper component (correlated with Component 7), 62 flakes, one side scraper (long axis beveled flake) (broken with the two pieces found 10 cm apart), and one short axis beveled flake from the middle component (correlated with Component 5), and about 1,265 flakes, 61 microblades, 1 microblade core, 1 flake core, and 7 bone/teeth fragments from the lower component (correlated with Component 3). However, only the A-Grid artifacts are enumerated; there are at least 622 other items from the other grid blocks, especially G-grid.

Kimura et al. (1989) associate a radiocarbon date of 3800±65 BP (N-4959) with the uppermost component, 5050±90 BP (N-4958) with the middle component, and 6040±110 B.P.

[1] However, the UAM accession for this year lists William Workman, UAA, as P.I.

(N-5225) with the lower component. None of these dates have point provenience, and were not noted in the 1985 catalog of all excavated materials. A generalized profile produced by Kotani (n.d.) shows considerable disagreement with the Kimura et al. (1989) profile (see Potter 2002). The stratigraphy, radiocarbon dates, and cultural material distributions have been correlated in Potter (2002). The upper component is considered Component 6, dating to 3800±65 BP. The middle component is considered Component 4, dating to between 7600 and 8300 BP. The lower component is considered Component 3, dating to around 9000 BP.

The 1985 Gerstle River collection was accessioned to the UAM (UA85-134-0001 through 1588 with 20 additional entries for the A-Grid, and at least 622 more catalog numbers for the G-Grid) by the State of Alaska archaeology permit, however these collections also never reached UAM. Kotani took the artifacts along with the loaned 1976 and 1977 Gerstle River collections to Japan in violation of the permit. Six of the ~2300 catalog numbers were returned to UAM in 2001. To date, the vast majority of materials from this collection have not been returned, including all of the faunal remains and documentation.

Figure A.3 1985 excavation at the Upper Locus Block A, view southeast, note backfilled 1983 excavation at right (photo courtesy of Charles Holmes).

Figure A.4 1985 excavation of the Upper Locus Block G, view south (photo courtesy of Charles Holmes).

1996 Testing

In 1996, further testing was undertaken at Gerstle River in order to resolve several issues relating to the site and potential conflicts relating to the proposed quarrying activities proposed by the Alaska Department of Transportation and Public Facilities (ADOT&PF) (Holmes 1998a). The purpose of the 1996 testing was to identify the limits of the cultural material at the Upper Locus, determine the nature of the archaeological components, and assess the potential for cultural remains at the Lower Locus (Holmes 1999, personal communication). The Upper Locus was mapped, and a series of five 1 m x 2 m test pits (TP 1-5) were excavated to the north and east of the main A-grid of the 1983, 1985 investigations. A single test pit was excavated at the edge of the bluff at the Lower Locus (designated "Bluff Test Pit") (Figures A.5-A.6). Excavations were conducted from July 8 to August 16, 1996 by Charles Holmes (P.I.), with the assistance of a crew of 3 to 8 people, including Richard VanderHoek (Field Director), Jonathan Durr, Robert Maguire, Barbara Crass, Robert Forshaw, David MacMahan, Kory Cooper, and Renee Petruzelli. Thomas E. Dilley described the stratigraphy and sediments (see Dilley 1998:278).

Cultural material was recovered from Test Pits 1, 2, 4, and 5, though Test Pit 3 did produce faunal remains. Thirteen radiocarbon dates were run on samples from the 1996 investigation, eight from the Upper Locus, three from the Bluff Test Pit, one date from a bluff face paleosol at the Lower Locus[2], and one date was obtained on an *Equus* sp. radius found in disturbed context at the Lower Locus. These dates and associations are detailed in Chapter 5. Several radiocarbon dates supported the correlation of two B horizons (R3 and R4) and a lower paleosol (P1) at the Upper and Lower Loci, though three radiocarbon dates were considered to be erroneous (Holmes 1998a: Figure 4; see also Potter 2002).

Test Pit 1 yielded a large mammal bone fragment, 1 gastrolith, and a number of other bone fragments within R5, Y4b, or both (Holmes 1998a:6; Potter 2002). No lithic material, other than a possible FCR fragment was recovered in Test Pit 1. Test Pit 2 yielded a microblade core facet rejuvenation flake, a spall scraper, seven flakes, and one flake lot, with various bone and teeth fragments associated with R4 to Y4 strata (correlated with Component 3) (Holmes 1996: 6; Potter 2002). Test Pit 3 yielded a possibly butchered *Cervus* L. tibia associated with Y3 stratum. No lithic materials were noted in Test Pit 3 (Holmes 1996: 6; Potter 2002). Test Pit 4 yielded 2 flakes, a *Cervus* R. metacarpal, other unidentified bone fragments, and gastroliths associated with strata Y4a to Y4b. In addition, burned long bones are associated with Paleosol 2, approximately 50 cm below the main cultural layer.

Test Pit 5, the closest unit to the 1983-1985 A-grid, yielded a number of artifacts and fauna. A single notched pebble was found in association with Y2 (correlated with Component 6). One burin, two burin spalls, three spall scrapers, three core fragments, nine microblades, 56 flakes, unburnt and calcined bone fragments, including 96 small mammal bone fragments, were found in association with Y4a (correlated with Component 3) (Holmes 1996: 6; Potter 2002).

Importantly, Holmes first discovered *in situ* cultural material at the Lower Locus, consisting of bone fragments, gastroliths, one flake, and one microblade fragment associated with Y4a at the Bluff Test Pit (Holmes 1998a: 10). A number of items were found on the surface of the Lower Locus, including two bifaces, one microblade, one hammerstone, flakes, a possible worked bone fragment, and various bone fragments from bison, horse, wapiti, and a possible *Saiga tatarica* (saiga antelope) humerus (Holmes 1998a:10).

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[2] This paleosol was not correlated with any known paleosol at the Lower Locus, and the date, 7325±200 (WSU-4894) cannot be linked to paleosol 1 (Holmes 1998a: 16; Holmes 1999, pers. comm.).

The 1996 collection was accessioned to the UAM (UA97-61-001 through 262) and remained in Anchorage at OHA until 2001, when these materials were sent to me. From 1996 to 1999, various other lithic and faunal materials were collected by Chuck Holmes, Robert Sattler (TCC), and others from the Lower Locus in disturbed contexts. These materials have been catalogued and incorporated into the 1997 collection by the author.

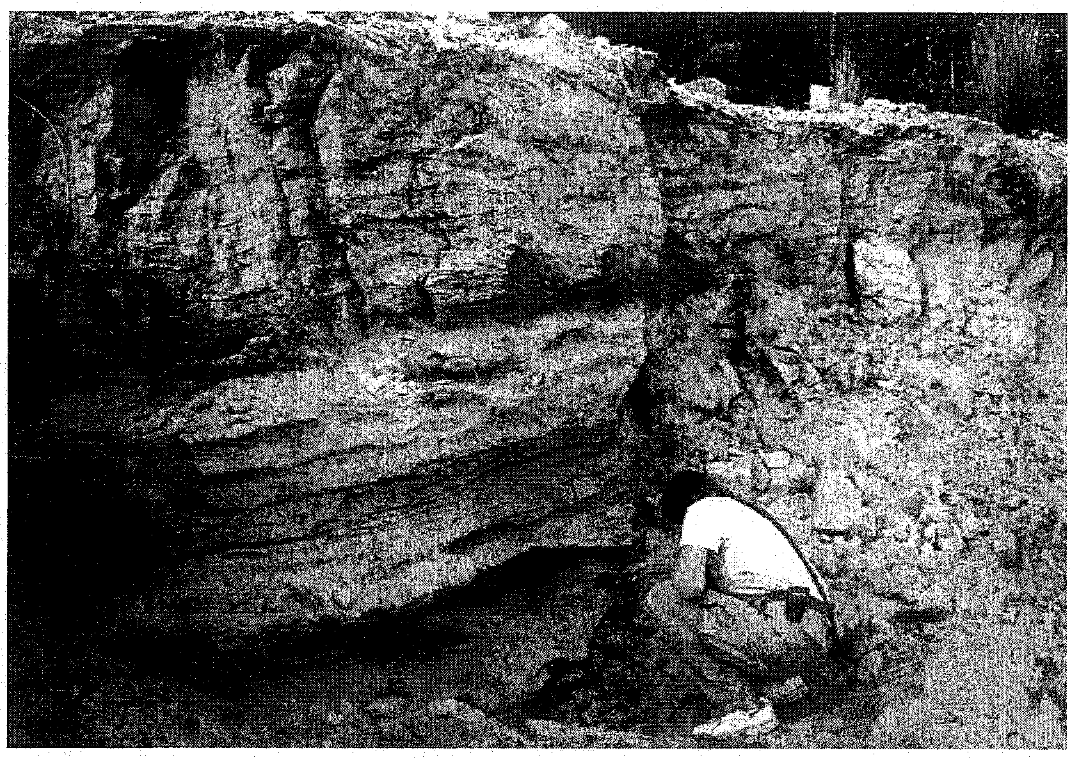

Figure A.5 Lower Locus bluff edge, later location of the 1996 Bluff Test Pit with *in situ* bone at ~20 cm below the dominant Bw horizon (R4), view northeast (photo courtesy of Charles Holmes).

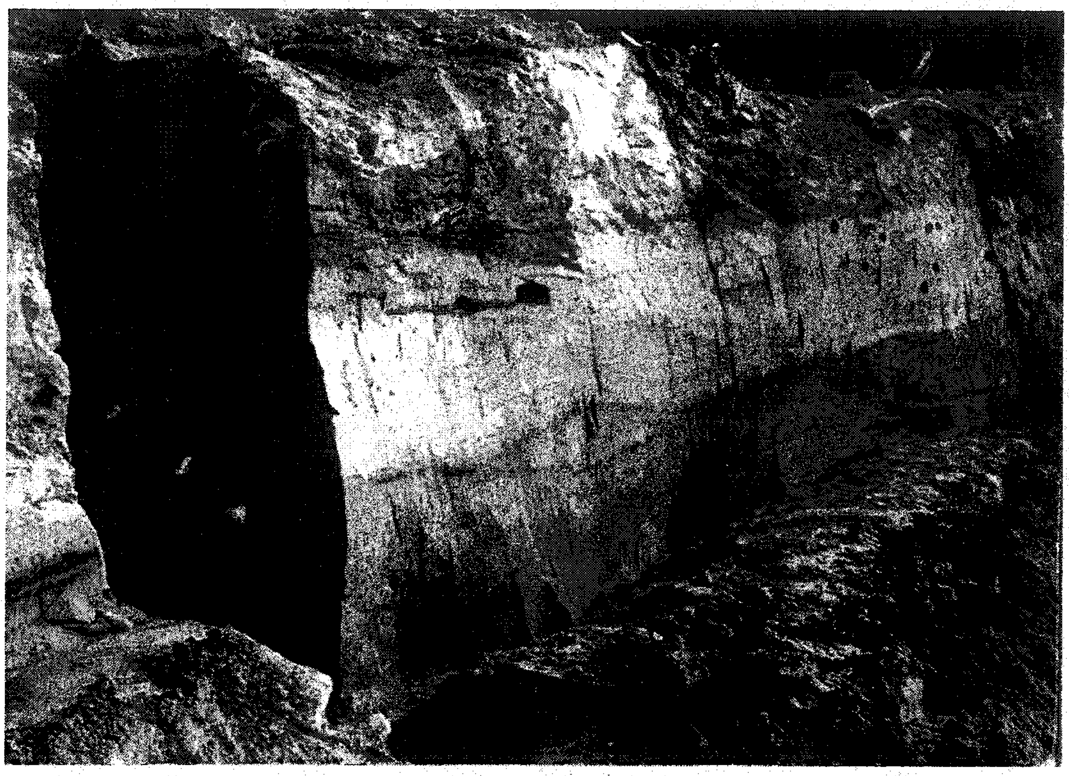

Figure A.6 Lower Locus bluff edge, after excavation of Bluff Test Pit (photo courtesy of Charles Holmes).

APPENDIX B: UPPER LOCUS STRATIGRAPHY AND INTER-LOCUS STRATIGRAPHIC CORRELATIONS

Gerstle River offers a rare opportunity to examine site structure and artifact patterning in stratified contexts relatively free from cryoturbation and other post-depositional disturbances. However, the majority of the data from excavation at Gerstle River Upper Locus remains to be collated and synthesized. Several ambiguities regarding radiocarbon dating and correlation of archaeological components occur in published and unpublished records (see Kimura et al. 1989, Holmes 1998a, Kotani n.d.). This section addresses these ambiguities by synthesizing the extant stratigraphic and archaeological data in the form of artifact distribution and radiocarbon assays and to briefly describe the components found at the Upper Locus. Much of this work appeared in earlier publications (Potter 2002, 2004).

This synthesis is based on the four published reports of the Upper Locus (Holmes and Dilliplane 1976, Rabich and Reger 1978, Kimura et al. 1989, and Holmes 1998a), original unpublished field notes, stratigraphic profiles, and spatial artifact data from the 1985 excavation by Kotani and the 1996 testing by Holmes. No excavations or laboratory analyses have been conducted at the Upper Locus as part of this investigation, therefore the correlations described here are provisional pending more detailed granulometric and other analyses at the Upper Locus.

Methods

Each investigation generated stratigraphic data in the form of profile drawings, allowing for comparisons among the various excavations. The 1976 report provided a single 50 cm wide profile drawn from the eastern edge of the bulldozed area (Holmes and Dilliplane 1976:VII-10). A total of 60 linear meters of stratigraphic profiles have been obtained from the Upper Locus: 16 m for the 1977 excavation, none for the 1983 excavations, 33 m for the 1985 excavation, and 11 m for the 1996 testing. There are three differing interpretations of the 1985 stratigraphic data and subsequent radiocarbon date associations: (1) the original field profiles interpreted by the field excavators, (2) Kimura et al. (1989), and (3) Kotani (n.d.). Photographs of excavation units and profiles are available for the 1996 investigations at the Upper Locus, although some oblique photographs are available for the 1977 and 1985 excavations (see Chapter 1).

Intrasite stratigraphic comparisons between the upper and lower loci are difficult but possible, primarily because of the number and nature of the various weathered B horizons, identified as R1-5 Rabich and Reger (1978: I-3); Kimura et al. (1989 Figures 3 and 4); Holmes (1998a, Figure 4); and Holmes (1999 pers. comm.). Previous stratigraphic interpretations are summarized below. In the original 1976 report, a soil profile was drawn from a cleaned bulldozer-exposed section near the eastern edge of the disturbed area (Holmes and Dilliplane 1976:VII-10). Three reddish oxidized loess zones are described, the lower two yielding artifacts. This is the only report of the three on the Upper Locus that links the Bw horizons with cultural components. This discrepancy could be the result of the compression of strata at the southern edge of the bluff (see Figures 1.4 and B.2). The 1977 investigation reported 11 stratigraphic units, including three red loesses and one reddish mottled loess, the last identified in only one square (N2W13).

The 1983 and 1985 excavations are critical to deciphering strata designation and cultural component position at the Upper Locus, as a large area was excavated, thousands of artifacts from multiple components were recovered and six radiocarbon dates were obtained. The 1983 and 1985 investigations yielded three different interpretations of the stratigraphy and radiocarbon date contexts (see below). The oxidized layers below the modern soil are termed "first" through "fifth red loess" or R1 through R5 (see above). Though nine red loesses are drawn for the G-grid field profiles, the remaining original field profiles were in general internally consistent among units in recording five red loesses.

An added difficulty is terminology used for the upper strata. Kimura et al. (1989) and Kotani (n.d.) list these as "Surface 1", which is almost certainly the root mat, "Surface 2", which is possibly the modern A horizon, and "Surface 3", which is possibly the modern B horizon. The B-Grid profile (Figure B.1) and Test Pit 5 (Figure B.2) are the closest stratigraphic profiles from the 1985 and 1996 investigations. The organic mat is somewhat thicker on Test Pit 5 and the B horizon is indistinct from R1 and R2 when compared with the A-grid profiles. The G-grid profiles show the tephra as equivalent to Surface 2. Without further excavation and sediment analyses at the Upper Locus, the relative identity and depth of "Surfaces 1-3" remain unclear. The labels in the following stratigraphic profiles (Figures B.1-B.2) follow those described for the

Lower Locus (see above). For clarity, any stratigraphic labels that differ from those established in this chapter are given in lower case (y6b, r1, etc.).

Correlation Methods

Because the 1976 data were collected with limited control over stratigraphy due to a small area of excavation at the edge of the bluff and lack of detailed profiles, they are not used in this study. During the 1985 investigation, no artifacts were recovered in C, D, and F-grids, and no profiles were obtained for D and F-grids, so the latter are not analyzed here. The remaining stratigraphic profiles were scanned, traced as line drawings, and grouped into units for the analysis on the basis of spatial position on the hill. Table B.1 presents each group, the number of linear meters and ordinal directions of stratigraphic profiles, and pertinent references. North and South walls generally run parallel to the margin of the hill while East and West walls transect the hillside (see Figure 1.4).

Table B.1 Stratigraphic profile summary data.

Group	*Linear meters*	*Ordinal direction(s)*	*Source*
		Upper Locus	
A-Grid	13	N, W, E walls	original field notes (N, E walls); Kimura et al. 1989 (N, W walls); Kotani n.d. (N wall)
A-Grid	3	N wall continuation	original field notes
B-Grid	3	N, E walls	original field notes
C-Grid	3	N, E walls	original field notes
E-Grid	3	N, W walls	original field notes
G-Grid	7	N, E walls	original field notes
TP 1-5	11	various	original field notes; Holmes 1998a
1977 Excavation	16	N, W, E walls	Rabich and Reger 1978
		Lower Locus	
Bluff Test Pit	3	N, E walls	original field notes; Holmes 1998a
Lower Locus (1999-2003)	95	various	This dissertation

The A-Grid data are discussed first due to the large size of the excavation area, conflicting interpretations, and extensive amount of available data in the form of field plan maps, artifacts, and feature descriptions. A stratigraphic model based on A-Grid patterns is evaluated against each excavation block from east to west (Grids A-B, B, C, E, and G) (Figure 1.4). For each block the A-grid model is accepted, tentatively accepted, or rejected. The model is then evaluated in relation to the 1996 test units at the Upper Locus and the Lower Locus excavation. Stratigraphic correlations among the 1983-1985 grids and the 1996 test pits at the Upper Locus and Lower Locus stratigraphy are based on several criteria, including continuity/discontinuity of various stratigraphic units, the average thicknesses of the Y and R layers, the distributions of radiocarbon dates, artifacts, and other features such as tephra, charcoal clusters, and organic stringers, and finally spatial patterns of strata characteristics in relation to terrain. Munsell color determinations are available for the 1985, 1996, and 1999-2001 excavations. While there are some variations in Munsell determinations among investigators, there are overall similarities in reddish versus yellowish loesses (ranging from 5YR 3/3 to 10YR 5/3 for the former and 2.5Y 6/4 to 10YR 5/6 for the latter).

Previous Interpretations of Stratigraphic Contexts of Radiocarbon Dates

Radiocarbon dates from the 1996 and 1999-2003 excavations all have point provenience, and most radiocarbon samples were taken from exposed profiles with excellent stratigraphic control (see Chapter 5). The lack of point provenience data for the radiocarbon samples obtained from the 1983 and 1985 excavations renders correlations difficult at best. Given the large amount of decomposed organic matter and charcoal fragments throughout the soils at this site, it is possible that contamination from recent forest fires affected the radiocarbon assays. The small suite of ~6000-7660 BP dates (n=3) obtained in 1983-1985 on Y4 are more difficult to explain, but as most of these have no exact provenience and given the considerable discrepancies among researchers during the 1985 excavation, these dates may be misleading.

Holmes (1998a) proposed that R2 dates to 3390 BP, R3 dates to 6200 BP, R4 dates to 8300 BP, and Paleosol 1 dates to 10000 BP. Holmes (pers. comm. 2000) considers two radiocarbon dates obtained in 1996 anomalous, a date of 2110±150 BP on charcoal within Y2, and 6470±310 BP on charred material in Y4 because they disagree with the majority of the radiocarbon assays acquired to date. Kotani (n.d.) proposed that Y1 dates to 3800 BP, R2 dates to 5050 BP, R3 dates to 6400 BP, and Y4b dates to 7660 BP. This interpretation is consistent with Holmes (1998a) with the exception of the 7660 date on Y4b. Kimura et al. (1989) correlate the radiocarbon dates with the strata and in their interpretation date Y1 to 3800 BP, R2 to 5050 BP, R3 to 6400 BP, and Y4a to 6000 and 7660 BP. These associations of dates with R2, R3, and Y4a are inconsistent with Holmes (1998a), but are consistent with Kotani (n.d), with the exception of the Y4a date of 7660 BP. These interpretations are evaluated below.

Stratigraphic Correlation Results

A-Grid

The A-grid (Figure B.1) is associated with the majority of the artifacts from the Upper Locus. The A-grid north wall (Kimura 1989:211) is derived directly from the field profiles of N10/W8-11. The A-grid west wall (Kimura 1989:211) is not among the profiles provided to Holmes by Kotani. The west wall is not identified by coordinates, though the strata contacts are consistent with the corner of N10/W11 section (the north wall of A-grid). However, there are some discrepancies in strata identification, including three red layers in place of two in the north section and different end-of-excavation levels. The layer labeled r5 in the original north wall profile is designated y6b ("yellowish mottled") in the north wall profile in Kimura et al. (1989).

Kotani's undated generalized profile is derived from the north wall of the A-grid (listed as 'major excavation') from below the lowest red loess to the surface, but it does not correspond to the north wall of the 1985 excavations. It possibly represents the north wall from the 1983 excavations in the A-grid. In this profile, r1 is split into an upper and lower red loess (r1a and r1b). Y1 appears as a discontinuous loess layer in between r1a and r1b. Therefore, the sequence is r1a-Y1-r1b-Y2, etc.; this is different than the Kimura et. al. (1989) sequence which is Y1-r1a-r1b-Y2, etc.

Table B.2 shows the published version of the general profile from the 1985 excavation, based on a four meter section (N10/W8-11). The original field drawing labels are in the second column, with the single generalized profile labels provided by Kotani to Holmes. It is somewhat difficult to reconcile the generalized stratigraphic profile labels drawn by Kotani with the field profile labeled during the 1985 excavation – the latter are the source for the Kimura et al. (1989) general profile. Moreover, the Kimura profile labels have changed from the field notes to publication. These discrepancies are crucial to understanding the provenience of several radiocarbon dates.

Table B.2 A-Grid stratigraphic correlations.

Field Profile Depth (N wall) cm BS	*field profile label (N wall)*	*Kimura et al. 1989 label (N and W walls)*	*Kotani n.d. label (N wall of "major excavation")*	*Depth from Kotani n.d. cm BS*	*A-Grid Model*
0-10	Surface 1	Surface 1			O horizon
10-12	tephra	tephra			tephra
12-18	Surface 2	Surface 2			A horizon
18-24	r1	Surface 3	r1b	5-23	R1
24-29	Y1	Y1 -3800 BP	Y1 (3800 BP, 4120 BP at lower contact)	23-33	Y1
29-48	r2	r1a-b	r1a (5050 BP)	33-45	R2
48-60	Y2	Y2	Y2	45-57	Y2
60-65	r3	r2 (5050 BP)	r2 (6400 BP)	57-72	R3
65-90	Y3	Y3	Y3	72-82	Y3
90-96	r4	r3 (6400 BP)	r3	82-91	R4
n/a	n/a	Y4 (not present on N wall) (6040 BP, 6090 BP) r4 (not present on N wall) y5 -7660 BP (not present on N wall)	n/a	n/a	n/a
96-110	Y4	y6a	Y4	91-116	Y4a
110-115	r5	y6b -on west wall (must be a mistake as it is noted as red in the field profile)	r5	~100	R5
115-150	Y4	y6c	Y5 -7660 BP		Y4b
150-151	P	P	P1		P1
151+	Y5	y6d	not labeled		Y5

The *A-grid model* developed below represents the general stratigraphic patterns of the original field profile designations of the 1985 excavation: (1) R1 and R2 are separated by a discontinuous Y1; (2) R2 is well developed; (3) R3 is continuous, well developed, and separated from R2 by continuous/discontinuous Y2; (4) Y3 is structurally complex with many thin organic stringers, charcoal concentrations and flecks, and compressed wood fragments; (5) R4 is continuous and well separated by Y3 and Y4 from R2 and R5 respectively; (6) R5 is discontinous and less developed than R4; (7) Paleosol 1 is discontinuous but appears in most profiles; (8) Bedrock was reached in most areas and sand layers directly overlay the bedrock; and (9) Artifacts were found associated with various layers (component designations are based on Kimura et al. 1989). There are inconsistencies in the provenience assigned to various components by Kimura et al. (1989) and Kotani (n.d.). Kimura et al. (1989) place the upper component within R1, the middle component within Y3, and the lower component in Y4, and R4, whereas Kotani (n.d.) places the upper component within Y1, which in his profile divides R1, the middle component within Y3, and the lower component in Y4, R5, and Y5.

The strata tend to compress at the south of the A-grid as illustrated in the east wall profile, and in the 1978 excavations (see Figures B.1-B.2). The A-grid east wall profile is consistent with the A-grid model using the same terminology for the original North wall; however, the southernmost area is difficult to discern. r4 (labeled) could be either R3 or R4, though most likely R3 given the discontinuous nature of R4. R1 and R2 have eroded, and Surface 1 and 2 remain.

No data relevant to artifact location is provided on the field profiles, but Kimura et al. (1989: 215-217) include three-dimensional graphs of artifacts recovered from the Upper Locus in 1985. From the vertical distributions, it is clear that these three components are separated and each has a unimodal vertical distribution. The upper component artifacts recovered in 1983 and 1985 consist of one black chert point base (of an unknown type), two obsidian secondary processing flakes, and a number of large flakes. One microblade was recovered from the middle component artifacts in 1983. Middle component artifacts recovered in 1985 include 64 flakes (primarily of black chert), one rhyolite sidescraper, and one endscraper of unstated material found in two pieces 10 cm apart. According to Kimura et al. (1989:213), charcoal excavated from this layer (Y3) dates to 5050±90 BP (N-4958), though in the accompanying figures, this date is associated with R2 (1989: Figure 3 and Table 1). The lower component artifacts recovered in 1983 consist of three concentrations in the southern part of A-grid, including one microblade core, about 40 microblades, and 160 flakes. In the 1985 excavation, 80 microblades and about 1,400 flakes in four concentrations were recovered in the lower component. A large sample of artifacts was assigned material type designations, and these descriptions are consistent with Component III material types at the Lower Locus and material types recovered from the 1977 excavation. These are primarily black and gray chert, with small amounts of obsidian and rhyolite flakes (Kimura et al. 1989:209-213). Several clusters of bone, teeth, and charcoal were found in association with the lithic artifacts, but no data regarding these concentrations are presented in the 1989 report. The A-model correlates the upper component with Y1, the middle component with Y3, and the lower component with Y4. The lower component is thus equivalent to Component 3 at the Lower Locus. The middle component may relate to Component 5 at the Lower Locus. The upper component is designated Component 7,and is not found at the Lower Locus.

B, C, and E-Grids

The B-grid (Figure B.1) is a continuation of A-grid to the west in the form of a trench seven meters long by 1-2 meters wide. The trench (N10/W16-19) was not excavated to the bedrock. There are several differences in the trench profile from the A-grid model as developed above: Y1 is not present, except at the extreme east, R3 consists of three thin red layers, and Y3 is not as complex, represented simply as a single yellow loess layer. Similarities with the A-grid model include: (1) general agreement on number, position, thickness, and continuity of the R layers, and (2) correlation of the tephras and Surfaces 1-2. The main B-grid (N10-11/W23) profiles consist of a west and east wall. Differences in these profiles from the A-grid model include (1) the separation of R3 into three thin red layers; and (2) absence of Surface 2. The sod appears to be equivalent to Surfaces 1 and 2 from the A-grid and general similarities include: (1) agreement on number, position, thickness, and continuity of the R layers; and (2) correlation of the tephra. Flakes are present within Y4, similar to the A-grid model, and probably represent Component 3, which has the largest number of artifacts within the A-grid excavated area.

The C-grid (Figure B.1) is located 5 m west of B-grid. Differences with the A-grid model include: (1) different spacing of R layers - R1 is much thinner (12 vs 35 cm in B-grid); (2) C-grid is not excavated to bedrock and thus the presence of all the R layers is uncertain; and (3) Y1 is structurally more complex and generally thicker. Similarities with the model include: (1) a continuous R4 and discontinuous R5; (2) a complex Y3 with many charcoal fragments; and (3) an overall agreement of the R layers. No artifacts were recovered in C-grid. The conclusion is that the C-grid is consistent with the A-grid model.

The E-grid (Figure B.1) is located 11 m west of C-grid, and 16 m west of B-grid. Differences with the A-grid model include: (1) R4 and R5 contact for a distance of 50 cm and a discontinuous Y4; (2) Y3 is not as complex; and (3) Y2 is more complex including many organic-rich layers. Similarities with the model include: (1) a general agreement of the R layers; (2) continuous R4; (3) discontinuous R5; and (4) matching general thicknesses of R layers (i.e., R2 is the thickest, then R3, then R1). Bedrock was reached in this unit. Overall, E-grid appears consistent with the A-grid model.

G-Grid

The G-grid (Figure B.1) is located 18 m west of E-grid, 29 m west of C-grid, and 34 m west of A-grid. Most of this unit is excavated to bedrock. It exhibits the most complex and unique strata at the Upper Locus, and indeed for the entire site. R5 appears to be better represented and more continuous, and thicker as it trends west (it was field labeled r9). Paleosols are not present, and strata from Y5 (field labeled as y9) and below appear compressed. Table B.3 lists the original G-grid field labels, the A-grid model equivalent, and the various depths.

Though no data were presented on G-grid artifacts in Kimura et al. (1989), the plan-views of three components were recorded in the original field notes. Unfortunately, these maps are unlabeled, having small "x" marks that almost certainly represent flakes or microblades, and larger line drawings that might represent cobbles or bone fragments, but which are clearly associated with the flakes. The lowest component is associated with y8 (between R4 and R5) and consists of 16 x-marks and one larger object (either bone or large artifact). The middle component is associated with y2-r2 and consists of 279 probable lithic artifacts and ten larger pieces. The upper component is associated with y2 and consists of ten probable lithic artifacts and seven large objects. The upper component occurs in one concentration at S4, W58, whereas the middle component occurs two concentrations, the main cluster (n=190 probable lithic artifacts) at S2, W58, and a smaller one (n=60 probable lithic artifacts) at S3-4, W58. It is possible that given the complex thin layers at G-grid, and the partial spatial separation of the components, these artifacts may actually represent a single component. The A-grid model correlates the upper component with Y1, the middle component with R2, and the lower component with Y4.

Two interpretations can be made regarding unit designation. First, the G-grid labeled units of r1 are equivalent to A-grid model R1, y1 to Y1, and G-grid r2 through r5 to A-grid R2. An alternative explanation is that G-grid r1 through r2 are equivalent to A-grid R1, G-grid Y2 is equivalent to A-grid Y1, and G-grid r3 through r5 is equivalent to A-grid R2. The lower units are as presented in Table B.3. Both interpretations are consistent with the artifact distributions. The component labeled as "upper" by Kimura et al. (1989) is present within Y1 in the A-grid. Artifacts are present in both y1 and y2 (G-grid designators). The second interpretation appears to be more likely, because r1 and r2 are combined for a longer distance (75 cm vs 20 and 30 cm), thus agreeing more closely with the A-grid model. Similarities with the A-grid model include:

(1) the agreement of G-grid y7a-c with A-grid Y3 due of the presence of many organic stringers; (2) although r9 (equivalent to A-grid R5) is mainly continuous, it is much thinner than r8 (A-grid R4); (3) there is a general agreement with the R layers; (4) the tephra appears in a similar stratigraphic position; (5) Surface 1-3 are similar; (6) y8 (A-grid Y4) contains artifacts; and (7) y1 and y2 (A-grid Y1) contains artifacts. The conclusion for G-grid is the tentative acceptance of the A-grid model pending further investigation.

Table B.3 G-grid stratigraphic correlations.

G-grid depth	*G-grid label*	*A-grid equivalent*	*A-grid depth*	*notes*
0-15	1 (surface)	Surface 1	0-10	
15-20	2 (tephra)	tephra	10-12	
20-27	3 (surface)	Surface 2	12-18	
27-35	r1	R1	18-24	
35-40	y1	Y1	24-29	cultural material
40-48	r2	R2	29-48	
48-50	y2			cultural material
50-62	r3			
62-63	y3			
63-78	r4			
78-82	y4			
82-88	r5			
88-100	y5a-b	Y2	48-60	
100-110	r6	R3	60-65	
110-115	y6			
115-120	r7			
120-140	y7a-c	Y3	65-90	
140-163	r8	R4	90-96	
163-170	y8	Y4a	96-110	cultural material
170-175	r9	R5	110-115	
175-213	y9a-c	Y4b, Y5?	115-151+	
213+	bedrock	bedrock		

Test Pit 1

Test Pit 1 (Figure B.2) was excavated by Holmes in 1996 and lies 25 m northwest of A-grid and 20 m northwest of B-grid. Artifacts appear in Y4a, which is consistent with the model. This unit was not excavated to bedrock due to permafrost. A radiocarbon date of 7600±140 (WSU-4888) was obtained from the lower part of R3. This is consistent with the Kotani (n.d.) and Holmes (1998a) chronologies, but is inconsistent with Kimura et al. (1989). Flakes were located at 140-150 cm below surface, within Y3 (see Holmes 1998a:6). The strata labeled "disturbed A horizon" on the original profile probably correlates to Surface 2 and possibly to Surface 3. R1 to Y4 is identical to the model, while the "mottled red" is equivalent to R5, and "P" to P1. Similarities to the A-grid model include: (1) relatively similar sequence of R layers; (2) consistent artifact location at Y5; (3) R5 is continuous, but thinner than R4. Dissimilarities with model include: (1) Y5/Y6 are listed above P1 (P1 should separate them); and (2) Y2 and Y3 appears more complex. The conclusion is acceptance of the A-grid model for this test pit.

Test Pit 2

Test Pit 2 (Figure B.2) was excavated in 1996 and lies 24 m northwest of the A-grid. This excavation terminated at bedrock. Similarities with the A-grid model include: (1) general position agreement of the R layers; (2) R5 (labeled as "red silt stringer") is discontinuous; (3) Y3 is complex with many organic stringers; (4) the paleosol is discontinuous but present; and (5) the cultural component is in Y4 between R4 and R5. Differences with the model include: (1) cultural material in R4, perhaps related to the Y4 component; (2) absence of tephra; and (3) a compact olive brown silt lies near the bottom of the unit. A microblade core fragment was recovered at 114 cm below surface, but most artifacts were found between 125 and 140 cm below surface, within Y3 (see Holmes 1998a:6). The stratum labeled "disturbed zone" appears to correlate to Surface 3. The conclusion is acceptance of the A-grid model.

Test Pit 3

Test Pit 3 (Figure B.2) was excavated in 1996 and lies 35 m northwest of A-grid. No R or Y layer is labeled below R2. R3 is present in the form of three to four thin red loess layers. Y3 (not labeled here) contains many organic stringers. R4 and R5 are not labeled in the field profile, and R4 could be one red layer. The "A soil horizon" could represent Surface 2 and 3. No artifacts were recovered, but a *Cervus* tibia exhibiting tool cutmarks was found at 109 cm below surface in the lower part of R3 or Y3 (see Holmes 1998a:6). R1 and R2 are only partially separated by Y1. R4 is continuous, but is apparently in direct contact with R5. The A-grid model holds for R4 and above, but is poor for the R4-Y4-R5 sequence.

Test Pit 4

Test Pit 4 (Figure B.1) was excavated in 1996 and lies 25 m west of A-grid. Strata thicknesses differ from nearby C-grid and are similar to Test Pit 1. The test pit was not excavated to bedrock. Strata are not labeled below R2 but the correlation appears relatively straightforward here. The R1-Y1-R2 boundaries are indistinct and cannot be separated. The general stratigraphic sequence below R2 is consistent with the A-grid model. R3 is represented by two discrete oxidized loess layers. A radiocarbon date of 6220±80 BP (WSU-4892) was obtained from the upper part of R3, and is in good agreement with the date from the Bluff Test Pit and the interpretation of Holmes (1998a) and Kotani (n.d.), but not with that of Kimura et al. (1989). Flakes were found at 137 cm below surface and 155 cm below surface, within the lower contact of R4/Y4 and the contact between Y4/R5 respectively (see Holmes 1998a:6). It is unknown if these depths are means or point proveniences on single items, they may represent one or more components. Burned bone was found within the lower paleosol and this is the only occurrence of fauna associated with this stratum at the site. Bones were found within R4, similar to Test Pit 2. The stratum labeled "disturbed A horizon" probably represents Surface 2 and 3. The conclusion is that the A-grid model works well for R2 and below.

Test Pit 5

Test Pit 5 (Figure B.2) was excavated in 1996 and lies 11 m north-northwest of A-grid and 7 m north of B-grid. This test pit was excavated to bedrock. Y1 is discontinuous, and there is a general agreement of the R and Y layer sequence. There is no equivalent to Surface 3, but this may be related to the A horizon. Artifacts were recovered from Y2 and Y4, which is consistent with the A-grid model. A date of 3390±65 BP (WSU-4890) was reported from R2 (labeled in TP5 as r1b), though sample provenience was not included on the profile. This date appears to be too recent given the general suite of radiocarbon dates if the dated material was within R2. It is possible that this assay dates material within Y1, given the indistinct boundaries of the upper R layer (Holmes, personal communication 2000). This date would therefore be consistent with those already obtained from Y1. A date of 2110±150 (WSU-4891) was associated with Y2, but this too appears young given the suite of dates available for Y1 through R3. A date of 8280±60 (ß-98434) was associated with R4 (labeled in TP5 as r3), that is consistent with Holmes (1998a) and Potter (2001b) dates but inconsistent with Kotani (n.d.) and Kimura et al. (1989). A date of 6470±310 BP (WSU-4893) was associated with Y4 that is consistent with Kotani (n.d.) and Kimura et al. (1989) but inconsistent with Holmes (1998a). A date of 10040±60 BP (ß-98436) was associated with the paleosol (P1) that is consistent with all of the hypotheses. A notched pebble was found 60 cm below surface, within Y2, and boulder spalls, microblades, flakes, gastroliths, and bones were recovered from Y4 (see Holmes 1998a:6). The conclusion is that the A-grid model works for the strata below R2 with the proviso that two of the dates appear too recent given the bulk of the other dates assuming that the associated strata are consistently identified, and several dates are inconsistent with at least one hypothesis (see Chapter 5).

1977 Excavation

The 1977 excavation (Figure B.2) yielded 16 linear meters of stratigraphic profiles. These units were on the edge of the eroding bluff and situated immediately south of the 1983 and 1985 A-grid. For the purposes of this analysis, the 1977 units are considered part of the A-grid. There is apparently only one 1977 excavation unit adjacent to the 1985 excavation. Units N6W8 (east wall) and N5W8 (north wall) have one corner (NE) which adjoins the 1983 excavation A-grid. The only R layer appearing at that interface is R4. As the 1977 profile continues west, other upper R layers appear. Several differences are apparent between the 1977 and 1985 profiles. R1 is absent, there is no tephra or paleosol present, and artifacts are not confined to Y4. However, the stratigraphic profiles are in general agreement with the A-grid model. Similarities include (1) a general agreement on R layers, (2) composition of R2 (two red loess layers), somewhat similar to the A-grid west wall, (3) R4 is the lowest continuous R layer, and (4) absence of R5.

Artifacts recovered from R3 through R4 in the 1977 excavation are possibly derived from Y4, given strata compression near the edge of the bluff. These artifacts probably represent those appearing in the larger and more controlled excavations of Kotani in 1983 and 1985 as components located in Y4 and Y3 respectively. The upper cultural component described by Rabich and Reger (1978:I-4) was associated with Y1 (the mottled loess overlying the uppermost oxidized stratigraphic layer), which agrees with Kimura et al. (1989) and Kotani (n.d.). The lower component was associated with R3 and R4 (middle and lowest oxidized units), and the excavators note that "it is possible that there are two distinct components, but that the distribution of each overlaps" (Rabich and Reger 1978: I-4). Given the relative vertical proximity of the middle and lower components observed by Kimura et al. (1989, see Figure 9), it is likely that Rabich and Reger recovered artifacts from both the middle and lower components in 1977. A radiocarbon date of 4120±170 BP (Gx-4950) was obtained at 24-32 cm below the surface within soil unit 2 ("mottled loess"). This date, at the lower limit of Y1 is consistent with the 3800±70 BP date on Y1 from the 1985 excavation and appears to be a good lower limiting date on the upper component. The conclusion is tentative acceptance of the A-Grid model though more work is needed on the provenience of the archaeological components.

Lower Locus

Detailed data on Lower Locus stratigraphy are provided above. This section discusses the correlation of stratigraphy between the Upper and Lower loci. A total of 95 linear meters of profiles were drawn for the Lower Locus in the course of this investigation (1999-2003) (see Figures 4.3-4.4, 4.7-4.9). An additional three meters with associated radiocarbon dates were provided in the 1996 investigation (Holmes 1998a:7).

In general, the surficial deposits of the Lower Locus are similar to those of the Upper Locus, consisting of a massive loess interbedded with buried paleosol horizons. Although the number and position of paleosols are similar to the Upper Locus, there are several differences. The Bwb horizons are generally thinner, suggesting that vegetation was not as well established on the southern hill as at the Upper Locus. The upper strata through R2 have been removed through recent blading at the Lower Locus. The Lower Locus has received a greater influx of sediments over comparable time spans than has the Upper Locus, probably due to its location nearer the present Gerstle River and lower elevation. The lower sediments (bedrock to stratum R4) are much deeper at the Lower Locus (3 m vs. 1 m at the Upper Locus).

All three radiometric dates from the 1996 Lower Locus tests correspond to Upper Locus dates (see Chapter 5). A date of 6250±60 BP (ß-98435) was recovered near the top of R3, corresponding to similar dates from R3 at Test Pits 4 and the bottom of R3 at Test Pit 1. A date of 8380±50 BP (ß-98433) recovered within R4 corresponds to a date from R4 at Test Pit 5. A date of 9970±60 BP (ß-98432) on paleosol 1 corresponds to a date from P1 at Test Pit 5. A date of 7330±200 BP (WSU-4894) was recovered from an unknown provenience at the Lower Locus and must be discounted due to this ambiguity. The remaining 18 radiocarbon dates obtained through this investigation follow a clear relationship with depth with no reversals. A site chronology for the Lower Locus based on these dates is presented in Chapter 5. The stratigraphic, radiocarbon, and artifactual data at the Lower Locus are remarkably consistent given the multiple years of research, the complicated stratigraphy, and the absence of the uppermost strata due to previous anthropogenic disturbances (see above and Chapter 5).

Upper Locus Cultural Components

A detailed discussion of site chronology is presented in Chapter 5. These data show congruity between the 1996 and 1999-2003 dates at the Lower Lower Locus, and these dates are considered more reliable than the 1977-1985 dates given the precise associated provenience information. According to Kimura, et al. (1989), Component 7 is dated to 3800 BP, Component 5 is dated to between 5050 and 6400 BP, and Component 3 at the Upper Locus is dated to between 6000 and 7660 BP. Kotani's profile illustrates five radiocarbon dates, including the date obtained by Rabich and Reger (1978) but excluding the 6040 and 6090 BP dates presented in Kimura et al. (1989). Kotani agrees with Kimura et al. (1989) on the stratigraphic placement and acceptance of the 3800 BP date, but on none of the others. The 5050 BP date is associated with R1, the 6400 BP date is associated with R2, and the 7660 BP date is associated with Y4b (labeled as y6c in Kimura et al. [1989]). The radiocarbon date associations are more consistent with Kotani's scheme, especially since the Y4a-R5-Y4b sequence does not appear on the North wall of the A-grid according to Kimura et al. (1989: 211). In sum, the data do not appear to support the interpretation of Kimura et al. (1989). The data from Chapter 5 support Holmes' (1998a) interpretation of the Upper Locus chronology. The stratigraphic correlations of the A-grid model with the provenienced radiocarbon dates and associated archaeological component distributions at the Upper Locus generally support the chronology of Holmes (1998a) but contradict those of Kotani (n.d.) and Kimura et al. (1989) who associate Y4 with dates ranging from 6000 to 7660 BP.

The stratigraphic distribution of the archaeological material support the delineation of four archaeological components present at the Upper Locus, and the radiocarbon dates are adequate for age estimates. Component 3, located 10-20 cm below R4 within Y4a is between 10000 and 8300 BP, and given its stratigraphic position, is likely contemporaneous with

Component 3 at the Lower Locus (~8900 BP, see Chapter 5). Component 3 materials at the Upper Locus include 2,303 unmodified flakes, 143 microblades, 1 microblade core/burin, two microblade core fragments, 1 microblade core facet rejuvenation flake, three boulder spall scrapers, one flake core, four cobbles, and an unknown amount of associated faunal remains. Component 5 (labeled Component IV in Potter 2002) is located within Y3, and has stratigraphic bracketing dates of 8280 and 7600 BP. Component 5 materials at the Upper Locus consist of 200 unmodified flakes, 1 modified flake, 8 microblades, one short axis beveled flake, and one long axis beveled flake. Component 6 (labeled Component V in Potter 2002) is located within Y2, and has stratigraphic bracketing dates of 6220 and 5050 BP. Component 6 consists of a single notched pebble. Component 7 (labeled Component VI in Potter 2002) is located within Y1 and has a stratigraphically associated date of 3800 BP and a lower limiting date of 4120 BP (see Chapter 5). Component 7 materials consist of 45 unmodified flakes, 3 modified flakes, 1 short axis beveled flake, and 1 projectile point base. Cultural materials from disturbed contexts at the Upper Locus consist of 351 unmodified flakes, 2 modified flakes, 5 microblades, 1 burin spall, 2 short axis beveled flakes, and 1 biface.

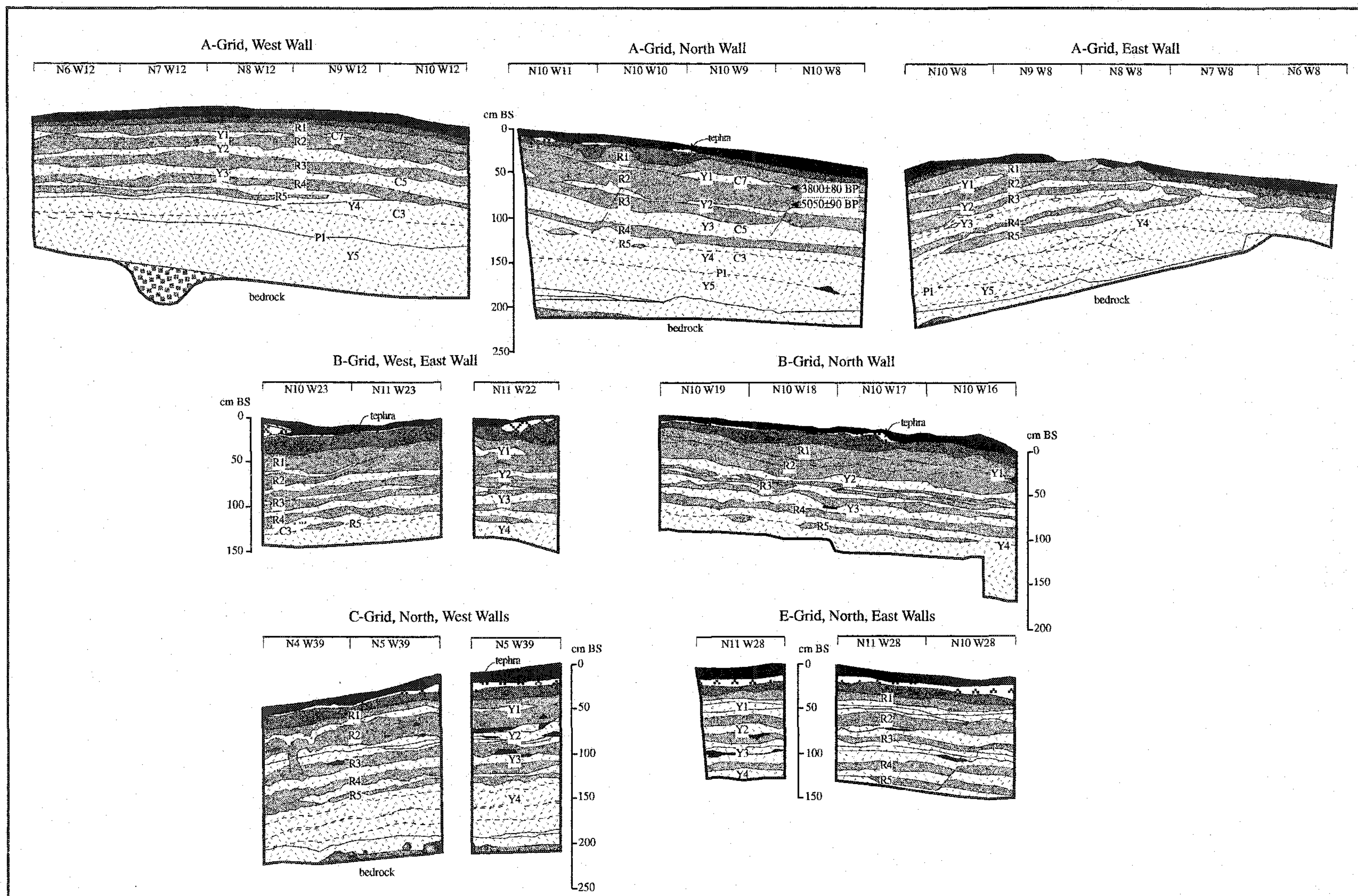

Figure B.1 Upper Locus stratigraphic profiles, 1983-1985 excavation, A, B, C, and E Grids.

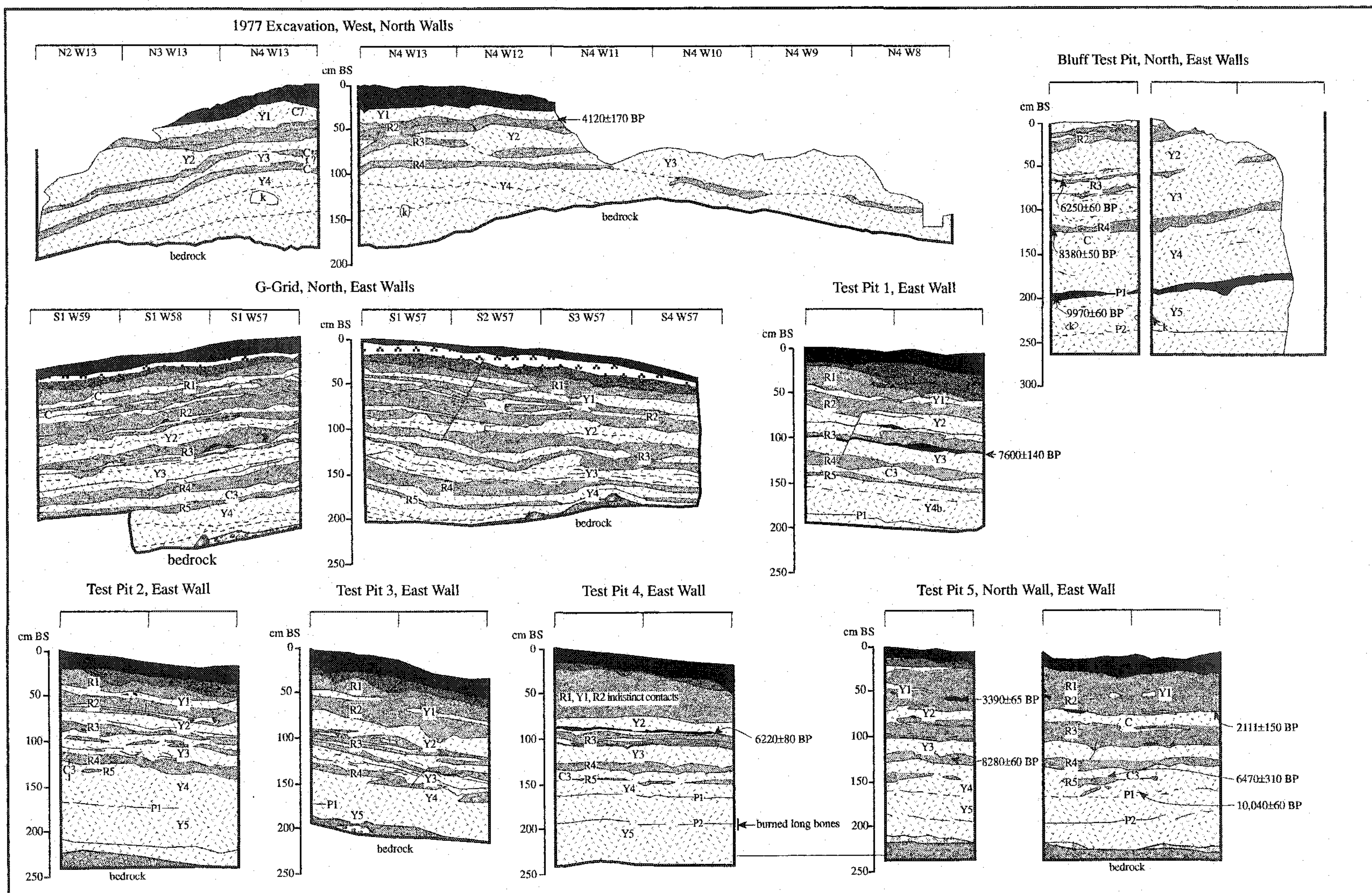

Figure B.2 Upper Locus stratigraphic profiles, 1977 and 1996 testing, and Lower Locus Bluff Test Pit.